FUNGI ASSOCIATED WITH OAT SEED IN KANSAS

by

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INTRODUCTION

As reported by the thirty-seventh biennial report of the Kansas State Board of Agriculture, oats, as a grain crop, is exceeded only by wheat, corn and sorghum, in that order, with reference to acres harvested. Although the oat crop is not considered a profitable cash crop, Clapp (8) stated that it does aid in the use of good rotation and provides good early harvested grain feed, especially for young stock.

The primary purpose of this investigation was the isolation and identification of the fungi present in samples of oat seed from different areas in the state. It was also hoped that a comparison of the abundance of fungus isolates could be shown with relationship to varieties of oats and the average overall rainfall for the different years.

It was hoped that this study may aid others in the recognition of fungi in any future studies which might be conducted with oats.

MATERIALS AND METHODS

According to Turner and Millard (39), seed infection may be that of mycelium only, which is common, or of spores, which is far less common. It was the opinion of the author, that spores should not be considered as infection of the seed, but rather an infestation of the seed.

The seed tested in this investigation was obtained from the Kansas State Seed Laboratory which obtains samples of oats harvested from all areas of Kansas.

The samples tested were the most popular varieties grown in the four-year period, 1950 through 1953. The years 1950 and 1951 were both "wet harvest" years while 1952 and 1953 were comparatively dry.

The varieties tested were Kanota, Fulton, Osage, Neosho, Cherokee and Nemaha. Certified seed was used whenever possible.

In Kansas, oats were grown primarily in the eastern two-thirds of the state (Fig. 1). The author attempted to obtain two representative samples for each variety grown each year, for each of the six agricultural divisions. The number of available samples for each year are shown in Table 1.

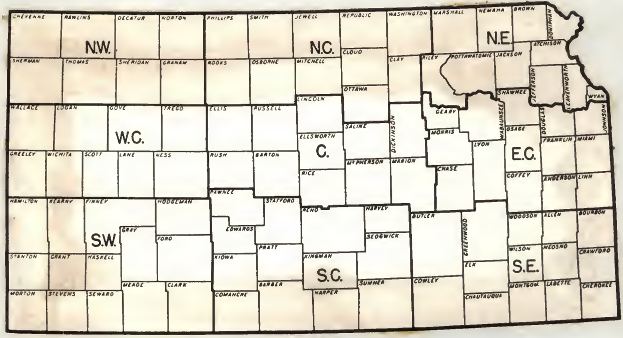

Fig. 1. Kansas crop-reporting districts.

Table 1. Available oat samples in Kansas.

Variety	1950	1951	1952	1953
Kanota	7	0	8	6
Fulton	7	0	5	3
Osage	4	0	2	0
Neosho	8	5	2	3
Cherokee	12	12	12	12
Nemaha	12	12	12	12

Samples were collected at random, taking care to allow only one sample per county, and preferably none that might represent state experimental fields from Riley or Ellis Counties. Any samples showing chemical seed treatment were also eliminated.

After the random selection of seed samples, each sample was given an accession number and its origin was recorded. One hundred seeds were counted out of each sample, for the plating test, on clean sheets of paper.

Each lot of (100) seeds was surface sterilized individually, by pouring the seeds into strainers and immersing them for one minute in 70 per cent ethyl alcohol and for one minute in a 1 per cent sodium hypochlorite solution.

According to Riker and Riker (32) sometimes special treatment to remove the air bubbles which would protect contaminants from tissue is combined with surface disinfections. They stated, "a previous treatment for one minute in 70 per cent ethyl alcohol before placing in the stronger disinfectant may accomplish the same results as the vacuum water pump method."

In a preliminary investigation by the author, it was found that this time limit of one minute was beneficial for fungus growth and helped eliminate bacteria which are apparently antagonistic toward fungi.

After surface sterilization, the seeds were plated out individually, 10 to a Petri dish, on potato dextrose agar (previously acidified with 5 per cent lactic acid to an approximate pH of 5). The dishes were then spread out singly on tables in the laboratory according to their assigned numbers. In this way it was possible to note stages of development in each Petri dish. At the end of 10 days each plate was examined for fungus and bacterial colonies. The different types were subcultured into test tubes and their origin recorded. With practice, several of the fungus colonies could be identified to at least the respective genus. Classification of each fungus to species required subculturing and microscopic examination.

After all of the initial isolations were made, it was necessary to plate several of the fungi on special media, since some of the fungus isolates failed to fruit in culture. Those that failed to fruit, even after special media was used, were placed in the unknowns. No attempt was made to classify bacterial isolates, although their occurrence was recorded.

Except for single isolations, tables were prepared individually for each of the fungi with reference to the sample, the year grown, the variety, the locality in which it was grown, and the percentage of infection in the sample.

The fungi mentioned in the first part of this thesis are those that have been isolated and identified from surface sterilized oat seed grown in Kansas. For the purpose of more orderly presentation, the fungi have been organized under the classes of fungi in their respective mycological order. The author thought it more feasible to deal with the review of the literature and experimental results collectively in order to eliminate repetition. A list of the fungi reported in the literature, but not isolated in this study, has been presented at the end of the thesis.

PHYCOMYCETES

As described by Gilman (13), the Phycomycetes are those fungi whose vegetative body may be unspecialized and converted as a whole into a reproductive organ at times bearing rhizoids or they may be mycelial and very extensive. Except for the most primitive members of this class which are unicellular, the Phycomycetes possess a mycelium which is usually aseptate. They may reproduce by asexual spores borne in sporangia. They may reproduce sexually by conjugation of similar gametangia to form zygospores, by conjugation of planogametes, or by fertilization of an egg cell to form oospores.

Mucorales

The mycelium of the Mucorales is composed of typically phycomycetous hyphae, which are stout and freely branched. Asexual reproduction is accomplished by means of aplanospores contained in sporangia, which are borne on single or branched sporangiophores. Sexual reproduction takes place by the copulation of two multinucleate gametangia which are similar in structure but may differ in size.

Mucoraceae. According to Alexopoulos (1), the family Mucoraceae is the largest group in the Mucorales. This family is characterized by the fact that no sporangiola or conidia are produced.

Mucor hiemalis Wehmer. The Phycomyetes were represented in this problem by only one representative fungus, that being Mucor hiemalis Wehmer (Table 2). Gilman (13) reported this species as having sporangiophores usually unbranched and erect, and then prostrate by wilting. The turf was close and fine, cottony, white and rarely grayish yellow (the author found the latter to be true). The sporangia were spherical, brownish yellow, visible to the naked eye, and averaged 52 microns in diameter. The spores were generally unequal, some elongate, or kidney-shaped. They were smooth, hyaline, and ranged 3-8.4 x 2-5.6 microns.

Machacek et al. (25) reported this genus as being isolated from oat seed in Canada, but none of their isolates was of this species. The author isolated this from only two samples of seed which have been shown in Table 3.

Table 2. Comparative abundance of seed-borne fungi in surface-sterilized oat seed produced in Kansas: A summary of tests on 156 samples.

Class	Genus	Species	Mean percentage of seeds infected	Total samples infected
Phycomycetes	Mucor			
		hiemalis	0.01	2
Ascomycetes	Aspergillus			
		amstelodami	0.31	8
		chevalieri	0.82	10
	Microascus			
		cirrosus	0.08	4
	Thielavia			
		terricola	0.53	45
		sp.	0.03	3
	Chaetomium			
		elatum	0.44	2
		dolichotrichum	0.31	12
		funicola	0.05	8
		indicum	0.82	29
		erectum	0.05	5
		trigonosporum	Tr. *	1
		murorum	0.06	4
		olivaceum	5.08	46
		globosum	1.83	38
		aureum	Tr.	1
		succineum	Tr.	1
		atrosporium	Tr.	1
		cristatum	Tr.	1
		gangligerum	0.02	3
		bostrychodes	0.05	7
		brasiliense	0.04	7
		spp.	0.13	18
	Sordaria			
		fimicola	0.93	64
		humana	Tr.	1
		anserina	Tr.	1
	Sporormia			
		australis	0.08	9
		intermedia	0.02	4
		minima	0.01	2
	Melanospora			
		zamiae	Tr.	1
	Rosellinia			
		limoniispora	0.04	7

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* Tr. - less than .01 per cent of total isolations.

Table 2 (cont.)

Class	Genus	Species	Mean percentage of seeds infected	Total samples infected
Deuteromycetes	Pyrenochaeta	sp.	Tr.	1
	Phoma	sp.	Tr.	1
	Alternaria	tenuis	3.04	43
	Curvularia	geniculata	0.09	7
	Helminthosporium	sativum	0.08	6
		tetramera	0.08	9
		spp.	0.01	2
	Periconia	igniaria	Tr.	1
	Stemphylium	botryosum	0.04	5
	Aspergillus	restrictus	Tr.	1
		terreus	Tr.	1
		wentii	0.03	3
		spp.	0.08	5
	Botrytis	spp.	0.04	4
	Cephalosporium	asperum	0.19	15
	Mycogone	nigra var. minor	Tr.	1
	Nigrospora	sphaerica	0.05	7
	Papularia	sphaerosperma	Tr.	1
	Penicillium	frequentans	0.04	1
	Pullularia	pullulans	0.08	11
	Scopulariopsis	brevicaulis	0.01	2
	Sepedonium	sp.	Tr.	1
	Sporotrichum	roseolum	0.40	33
	Isaria	sp.	0.11	9

Table 2 (concl.).

Class	Genus	Species	Mean percentage of seeds infected	Total samples infected
Deuteromycetes				
	Fusarium			
		roseum	0.13	8
		moniliforme	0.05	4
		equiseti	Tr.	1
		spp.	0.05	6
	Rhizoctonia			
		solani	Tr.	1
	Unknown	----------	0.63	59

Table 3. Comparative samples of seed infected with Mucor hiemalis.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
16	1950	Osage	Rice (C)	1
32	1950	Cherokee	Sumner (SC)	1

ASCOMYCETES

In the Ascomycetes the mycelium is well developed, septate, and usually richly branched. The typical structure of the Asomycetes is the ascus which has a definite number of spores, usually eight. The sexual fruiting body (ascocarp) is multicellular and has a sterile envelope. The asexual stage of reproduction in the Ascomycetes is typified by the production of conidia. Ascomycete classification is based entirely on the characteristics of the perfect stage. There are no motile spores produced by any species. According to Alexopoulos (1), some of the criteria which have been used to separate different groups are: the type of ascocarp, the nature of the ascocarp wall, the color of the ascocarp, the nature of the substratum, the type of ascus, the position of the asci in the ascocarp, the type of ascal opening, and the presence of paraphyses.

Aspergillales

Members of the Aspergillales produce their cleistothecia on the mycelium without the formation of a stroma.

Aspergillaceae. Members of this family characteristically produce cleistothecia that are usually small, and have a thin, dark, carbonaceous or brightly-colored peridium, which remains closed at maturity. The asci are irregularly crowded in the cleistothecia and are two to eight spored.

Aspergillus. If ascocarps were produced, the genus Aspergillus could be partially identified on the basis of the bright colored walls of the cleistothecia, or if the imperfect stage only was produced, conidiophores were recognized by the foot cells and vesicular tips. To identify isolates of this genus, it was necessary to plate each one out on Czapeks solution agar in order to induce sporulation. There were five species of Aspergillus isolated from oat seed. Two of these isolates have been considered with the Ascomycetes, while the others isolated have been considered under the Deuteromycetes in their respective orders.

Aspergillus _amstelodami_ (Mangin) Thom and Church. Members of this species are quite often represented by both a perfect and an imperfect stage.

Colonies upon Czapek's solution agar were restricted, 4 to 6 cm in diameter, closely wrinkled, yellow to yellow gray in color from abundant perithecia admixed with sterile hyphae. Under perithecial areas, colonies were persistently yellow and more or less green where conidial areas predominated (Plate I).

The author identified this species, as well as others, with the aid of the description by Thom and Raper (38). According to their description, the perithecia were globose to subglobose, mostly 115 to 140 microns in diameter, not covered by a mat of sterile hyphae; asci were mostly 10 to 12 microns, 8 spored; an outstanding identifiable feature was the lenticular ascospores, 4.7-5.0 microns by 3.6-3.8 microns, with prominent V-shaped equatorial furrows and broad irregular ridges, and with walls roughened over their entire surface.

Isolates of this species agreed with Thom and Rapers' (38) description, except that no green tints to the conidia were noted.

Aspergillus amstelodami represented 1.8 per cent of the total isolations of all seed samples. The greatest number occurred in a sample of 1950 Cherokee grown in Clay County in North Central Kansas. The comparative samples of this fungus are shown in Table 4.

EXPLANATION OF PLATE I

Pure Cultures of:

Fig. 1. *Aspergillus wentii*

Fig. 2. *Aspergillus chevalieri*

Fig. 3. *Aspergillus amstelodami*

Fig. 4. *Aspergillus restrictus*

Fig. 5. *Aspergillus terrus*

PLATE I

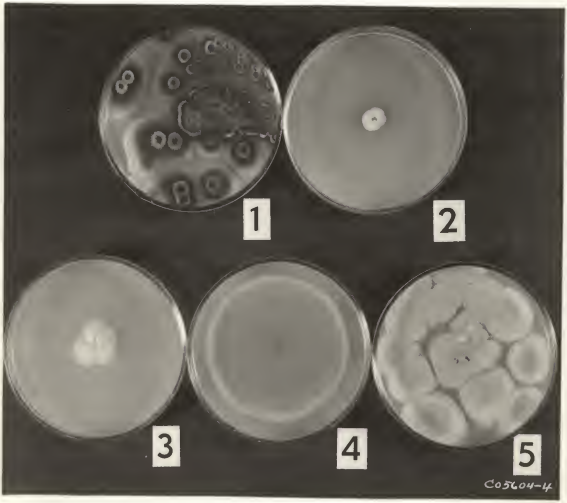


Table 4. Comparative samples of seed infected with Aspergillus amstelodami.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
28	1950	Cherokee	Clay	(NC)	11
77	1951	Nemaha	Morris	(EC)	6
99	1952	Cherokee	Dickinson	(C)	3
131	1953	Neosho	Morris	(EC)	3
136	1953	Cherokee	McPherson	(C)	3
138	1953	Cherokee	Kingman	(SC)	10
141	1953	Cherokee	Linn	(EC)	2
153	1953	Nemaha	Osage	(EC)	10

Aspergillus chevalieri (Mangin) Thom and Church. According to Thom and Raper (38), the species name is limited to strains bearing ascospores with smooth walls and prominent, thin equatorial crests, because they believe these strains most nearly represent the organism described by Mangin in 1909.

Colonies upon Czapeks solution agar, were restricted, closely felted, and heads of conidia and perithecia were largely confined to the marginal area, orange or yellowish at the margin, darker in the center (Plate I).

Perithecia were abundant, mostly 100 to 140 microns, yellow to orange; asci 9 to 10 microns, ascospores lenticular, 4.6 to 5.0 microns by 3.4 to 3.8 microns with walls smooth, equatorial crests prominent, thin, and quite often recurved.

Conidial heads, when produced, were a pale green in color; conidiophores were enlarged to a vesicular apex; sterigmata were in a single series and closely packed.

This species constituted 4.8 per cent of the total isolations. The greatest number of colonies isolated from a single seed sample were those obtained from 1951 Neosho seed from Marshall County, which are shown, along with other samples infected with *Aspergillus chevalieri*, in Table 5.

Table 5. Comparative samples of seed infected with *Aspergillus chevalieri*.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
3	1950	Kanota	Marion (C)	2
13	1950	Fulton	Montgomery (SE)	9
28	1950	Cherokee	Clay (NC)	17
54	1951	Neosho	Marshall (NE)	45
65	1951	Cherokee	Geary (EC)	20
89	1952	Fulton	Smith (NC)	1
97	1952	Cherokee	Cloud (NC)	3
106	1952	Cherokee	Lyon (EC)	28
121	1953	Kanota	Dickinson (C)	2
131	1953	Neosho	Morris (EC)	1

Microascus cirrosus Curzi. As characterized by Whitehead (41), perithecia were black, globose about 100 microns in diameter, with a short cylindrical beak 30 microns long, usually buried in the mycelial mat, except for the beak. Asci were globose to ellipsoid, 8-spored, wall deliquescing early, 10-12 x 8-10 microns. The ascospores were hyaline, 1-celled, 5-6 x 4-4.5 microns elliptic in one view, elliptic flattened to crescent-shaped in another view, ends rounded. (Plate IV)

Isolates of this fungus made up a total of 0.5 per cent of the total isolates. It was found associated with only four samples of seed which are shown in Table 6.

Table 6. Comparative samples of seed infected with Microascus cirrosus.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
44	1950	Nemaha	Kingman	(SC)	6
52	1951	Neosho	Kingman	(SC)	4
94	1952	Osage	Reno	(SC)	2
110	1952	Nemaha	Cloud	(NC)	1

Thielavia terricola (Gilman and Abbott) Emmons. The genus Thielavia belongs to the family Aspergillaceae and differs from Aspergillus primarily in that the ascocarps have dark colored walls, while Aspergillus has bright walls (Plate IV).

Isolates of Thielavia terricola comprised 3.1 per cent of the total isolations.

Colonies on potato dextrose agar were broadly spreading, composed of snowy-white hyphae in a compacted mass.

Ascocarps were 80-125 microns in diameter, brownish to almost black at maturity. The color was largely due to masses of dark spores within. The outer wall of the cleistothecium was somewhat carbonized. Asci were oval to pyriform, 16-19 x 25-35 microns, and deliquesced within the cleistothecium. The ascospores were broadly fusiforme or elliptical, slightly apiculate at both ends, dark olivaceous to brown, 7-9 x 10-16 microns (7.5 x 11.5), with a wall much thickened at the end of the germ pore. Gilman (13) reported this fungus as occurring quite commonly in soil.

The author felt a significant factor was shown on the occurrence of this fungus, since there was a limitation on the available samples of 1951 and 1952 seed. A true average could probably have been shown had the maximum samples been available. The occurrence of Thielavia terricola is shown in Table 7.

Table 7. Comparative samples of seed infected with Thielavia terricola.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
3	1950	Kanota	Marion	(C)	3
5	1950	Kanota	Marshall	(NE)	1
12	1950	Fulton	Sedgwick	(SC)	2
14	1950	Fulton	Elk	(SE)	1
15	1950	Osage	Jewell	(NC)	1
16	1950	Osage	Rice	(C)	4
17	1950	Osage	Kingman	(SC)	1
18	1950	Osage	Reno	(SC)	1
26	1950	Neosho	Cowley	(SE)	1
29	1950	Cherokee	McPherson	(C)	2
32	1950	Cherokee	Sumner	(SC)	1
36	1950	Cherokee	Wabaunsee	(EC)	1
44	1950	Nemaha	Kingman	(SC)	1
58	1951	Cherokee	Barton	(C)	2
62	1951	Cherokee	Brown	(NE)	4
63	1951	Cherokee	Nemaha	(NE)	1
68	1951	Nemaha	Osborne	(NC)	3
70	1951	Nemaha	Dickinson	(C)	2
72	1951	Nemaha	Kingman	(SC)	1
77	1951	Nemaha	Morris	(EC)	2
84	1952	Kanota	Kingman	(SC)	1
85	1952	Kanota	Harvey	(SC)	1
95	1952	Neosho	Russell	(C)	1
97	1952	Cherokee	Cloud	(NC)	1
102	1952	Cherokee	Kingman	(SC)	3
121	1953	Kanota	Dickinson	(C)	2
122	1953	Kanota	McPherson	(C)	2
124	1953	Kanota	Harper	(SC)	2
125	1953	Kanota	Marshall	(NE)	1
127	1953	Fulton	Kingman	(SC)	3

Table 7 (concl.).

Sample No.	Year	Variety	Locality		Fungus percentage per sample
128	1953	Fulton	Sumner	(SC)	1
129	1953	Fulton	Cowley	(SE)	1
130	1953	Neosho	Dickinson	(C)	2
131	1953	Neosho	Morris	(EC)	1
133	1953	Cherokee	Clay	(NC)	1
134	1953	Cherokee	Jewell	(NC)	2
137	1953	Cherokee	Sedgwick	(SC)	1
138	1953	Cherokee	Kingman	(SC)	2
142	1953	Cherokee	Osage	(EC)	2
145	1953	Nemaha	Jewell	(NC)	4
147	1953	Nemaha	Ellsworth	(C)	1
148	1953	Nemaha	Barton	(C)	2
149	1953	Nemaha	Stafford	(SC)	1
150	1953	Nemaha	Kingman	(SC)	9
156	1953	Nemaha	Neosho	(SE)	1

Thielavia sp. This group was isolated in small amounts from 1950 and 1951 seed samples, and were tentatively placed in the genus Thielavia.

The mycelium was white to dark red. The cleistothecia were black, globose, and covered by dark red hyphae. Asci were clavate 34-36 x 6-7 microns; walls deliquesced very early. Ascospores were uniseriate in the ascus, becoming black or dark brown at maturity, 1-celled, ellipsoid to elliptic fusoid, 10-13 x 6-7 microns with germ pore at one end. No conidia were seen.

The hairy cleistothecia and uniseriate ascospores might indicate that these isolates should have been placed in another genus. Samples infected with this fungus are shown in Table 8.

Table 8. Comparative samples of seed infected with Thielavia sp.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
15	1950	Osage	Jewell	(NC)	1
17	1950	Osage	Kingman	(SC)	2
76	1951	Nemaha	Wabaunsee	(EC)	1

Sphaeriales

The order Sphaeriales, according to Alexopoulos (1), is the largest order of the Ascomycetes. The Sphaeriales include all Pyrenomycetes with dark, leathery, globose or pear-shaped perithecia, each with a well-developed ostiole. The perithecia may form directly from loose mycelial hyphae, or are associated with a well-developed stroma.

Chaetomiaceae. The perithecia are covered with hairs, which in most species are long and curly. Asci are generally evanescent; the lemon-shaped ascospores are released in the perithecium and escape through the ostiole.

Chaetomium. The genus Chaetomium was erected in 1817 by Kunze, based upon Chaetomium globosum Kze. According to Skolko and Groves (33), the present day concept of the genus includes those species with subglobose to elongate, colored, superficial perithecia that are provided with an ostiole. Variously modified hairs are produced from the cell walls which are membranous and cellular. The terminal hairs may be spine-like, arched, flexed, coiled, circinate, or variously branched. The asci are thin-walled and evanescent, usually clavate, sometimes cylindrical, typically 8-spored. The spores are typically lemon-shaped, but variations in spore size may range from globose to fusiform, triangular, or in one case square.

The genus was monographed by Chivers in 1915 and as reported by Skolko and Groves (34), he retained only 28 species (11 described by him), from the 114 species and 14 varieties that had previously been referred to the genus. They also stated that since that date about 30 new species have been described, some of which have already been invalidated through synonymy. They predicted that about 50 species will survive and new species will undoubtedly be added.

The wisdom of Chivers in utilizing the branched character of the perithecial hairs as a major point of segregation, was doubted by Skolko and Groves (34) because in some species the branching is very inconspicuous. He also utilized such variable characters as coloration of the substratum or medium upon which the fungus might be growing, the rhizoidal attachment of the perithecium, and the incrustation of the hairs which seems dependent on age and may dissolve in the mounting medium.

Skolko and Groves (34) suggested that the shape and size of the perithecia, conspicuous characters of the hairs, and the shape and size of the spores provide a more practical basis for species separation. According to their key, the first consideration was the shape of the perithecium. Secondly, they utilized terminal hair characteristics, which may be terminal hairs dichotomously branched, straight, flexed to long undulate, arcuate, sinuous to loosely coiled, spirally coiled, or in reversed loops. Final determination may be on spore measurement or any other distinguishable characteristic.

Although Chaetomium species (Alexopoulous 1), are for the most part saprophytic, they are of particular economic importance as cellulose-destroying fungi which grow on paper and fabrics sometimes causing considerable damage. It has been observed by the Canadian workers (34), that seed samples heavily infected with Chaetomium show a correspondingly low germination.

Chaetomium as a genus showed a greater percentage of occurrence than any other fungus, in the entire four-year seed samples.

The first group to be considered, according to the presentation by Skolko and Groves (33), were those possessing dichotomously-branched hairs. In their key, all of the species in this group produced perithecia with terminal hairs that were essentially straight. The next step again segregated the original group into two groups.

The first of the two groups encompassed species producing unbranched terminal hairs, in addition to dichotomously-branched hairs.

Chaetomium elatum Kunze ex Fries. Isolates of Chaetomium elatum possessed large perithecia, quite often up to 450 microns wide; the terminal hairs were coarsely roughened, stout, 5-8 microns wide, and the spores were lemon-shaped and measured 8.5-9 x 11-13 microns (Plate II). The sum of all the isolates of this species made up 2.6 per cent of the total isolations from oat seed. It was also noted that this species occurred in

EXPLANATION OF PLATE II

Pure Cultures of:

Fig. 1. *Chaetomium atrosporium*

Fig. 2. *Chaetomium bostrychodes*

Fig. 3. *Chaetomium brasiliense*

Fig. 4. *Chaetomium cristatum*

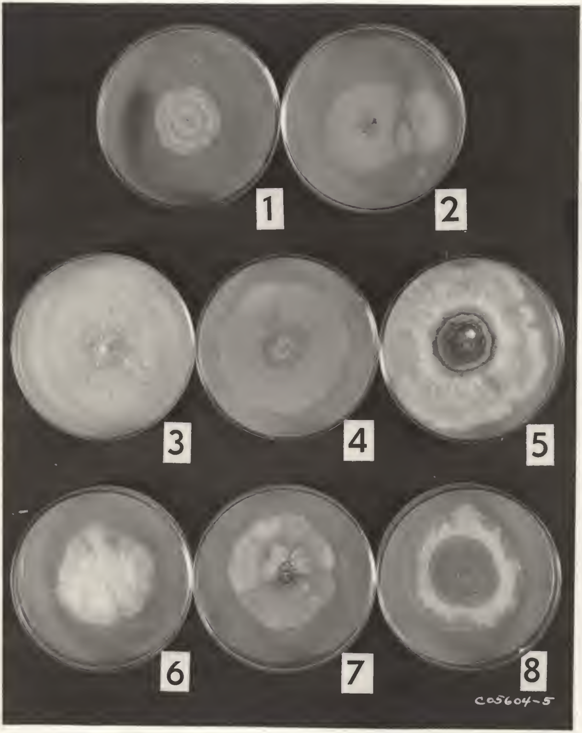
Fig. 5. *Chaetomium dolichotrichum*

Fig. 6. *Chaetomium elatum*

Fig. 7. *Chaetomium erectum*

Fig. 8. *Chaetomium funicola*

PLATE II



only two samples of seed. The greatest prevalence was recorded from a sample of 1950 Kanota which had been grown in Republic County. The occurrence of this species is shown in Table 9. This was the first time this fungus has been reported from oat seed in Kansas.

Table 9. Comparative samples of seed infected with Chaetomium elatum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
1	1950	Kanota	Republic	(NC)	65
93	1952	Osage	Rice	(C)	4

Chaetomium dolichotrichum Ames. This species produced both branched and unbranched hairs at maturity. Cultures at first appeared white to gray, becoming a deep olive color with perithecial formation (Plate II).

Perithecia were smoky-gray colored, globose to subglobose, 100-150 microns in diameter, produced early, at the center of the culture. Spores were light brown, oval to ovoid, and measured 4.0-5.5 x 6.0 microns.

Chaetomium dolichotrichum made up 1.8 per cent of the total of all isolations. Skolko and Groves (33) reported this species as being isolated from the seeds of flax, peas, and radish. As far as the author could determine, this was the first time this fungus had been reported from oat seed. Comparative abundance of this species is shown in Table 10.

The greatest occurrence of this species was recorded as 24 per cent, which occurred in a sample of 1953 Nemaha, grown in the central part of the state in Ellsworth County.

Table 10. Comparative samples of seed infected with Chaetomium dolichotrichum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
25	1950	Neosho	Osage	(EC)	1
70	1951	Nemaha	Dickinson	(C)	1
74	1951	Nemaha	Brown	(NE)	1
97	1952	Cherokee	Cloud	(NC)	1
118.	1952	Nemaha	Morris	(EC)	2
122	1953	Kanota	McPherson	(C)	8
124	1953	Kanota	Harper	(SC)	5
125	1953	Kanota	Marshall	(NE)	2
132	1953	Neosho	Cowley	(SE)	1
133	1953	Cherokee	Clay	(NC)	2
136	1953	Cherokee	McPherson	(C)	1
147	1953	Nemaha	Ellsworth	(C)	24

Chaetomium funicola Cooke. This species was isolated in only negligible amounts as shown by Table 2. Macroscopically, Chaetomium funicola could very easily have passed for Chaetomium dolichotrichum, but microscopically, Chaetomium funicola differed in its straight, short projecting, unbranched terminal hairs and the stout, straight, roughened acute branches of the branched terminal hairs (Plate II) as described by Skolko and Groves (33). This species was reportedly isolated from oat seed in Canada by Machacek et al. (25). The author found no reports of this fungus being isolated in Kansas before. Its occurrence is shown in Table 11.

Table 11. Comparative samples of seed infected with Chaetomium fimicola.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
16	1950	Osage	Rice	(C)	1
68	1951	Nemaha	Osborne	(NC)	1
117	1952	Nemaha	Osage	(EC)	1
126	1953	Kanota	Cowley	(SE)	1
132	1953	Neosho	Cowley	(SE)	1
139	1953	Cherokee	Marshall	(NE)	1
152	1953	Nemaha	Jackson	(NE)	1
153	1953	Nemaha	Osage	(EC)	1

The next group includes two species of Chaetomium with dichotomously-branched hairs only.

Chaetomium indicum Corda. As stated above, Skolko and Groves (33) described Chaetomium indicum as possessing no unbranched terminal hairs or at least they are obscure at maturity. Chaetomium indicum formed a close network of its dichotomously-branched hairs and the perithecia measured up to 200 microns wide. This species represented 4.8 per cent of the total isolations as shown in Table 2. Heaviest infection occurred in 1953 Nemaha seed, grown in Kingman County. Occurrence of this species is shown in Table 12.

Table 12. Comparative samples of seed infected with Chaetomium indicum.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
4	1950	Kanota	Russell (C)	1
16	1950	Osage	Rice (C)	2
21	1950	Neosho	Dickinson (C)	12
24	1950	Neosho	Marshall (NE)	1
29	1950	Cherokee	McPherson (C)	1
51	1951	Neosho	Barton (C)	2
70	1951	Nemaha	Dickinson (C)	3
77	1951	Nemaha	Morris (EC)	1
80	1952	Kanota	Phillips (NC)	2
87	1952	Kanota	Elk (SE)	3
92	1952	Fulton	Sumner (SC)	4
93	1952	Osage	Rice (C)	2
95	1952	Neosho	Russell (C)	1
99	1952	Cherokee	Dickinson (C)	2
110	1952	Nemaha	Cloud (NC)	1
112	1952	Nemaha	Ellsworth (C)	1
116	1952	Nemaha	Jackson (NE)	2
122	1953	Kanota	McPherson (C)	2
131	1953	Neosho	Morris (EC)	1
138	1953	Cherokee	Kingman (SC)	2
139	1953	Cherokee	Marshall (NE)	2
140	1953	Cherokee	Leavenworth (NE)	6
145	1953	Nemaha	Jewell (NC)	4
146	1953	Nemaha	Ottawa (NC)	25
148	1953	Nemaha	Barton (C)	3
149	1953	Nemaha	Stafford (SC)	13
150	1953	Nemaha	Kingman (SC)	25
154	1953	Nemaha	Morris (EC)	1
155	1953	Nemaha	Elk (SE)	3

Chaetomium erectum Skolko and Groves. As described by Skolko and Groves (33), Chaetomium erectum was quite similar to Chaetomium indicum, but differed in that the perithecia were smaller, measuring up to 140 microns and the hairs were rigidly and sparsely branched (Plate II). Chaetomium erectum was isolated in only small amounts as shown in Table 2. This was the first report of this fungus associated with oat seed in Kansas. The comparative abundance of this fungus is shown in Table 13. This fungus was not found associated with any of the 1953 samples.

Table 13. Comparative samples of seed infected with Chaetomium erectum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
14	1950	Fulton	Elk	(SE)	1
16	1950	Osage	Rice	(C)	1
70	1951	Nemaha	Dickinson	(C)	1
78	1951	Nemaha	Allen	(SE)	4
82	1952	Kanota	Dickinson	(C)	1

The remaining fungi belonging to the genus Chaetomium are those possessing no dichotomously-branched hairs.

Chaetomium trigonosporum (Marchal) Chivers. Chaetomium trigonosporum was given by Skolko and Groves (34), as having perithecia that were brown to black, erect, distinct, with sparse, brown terminal hairs, and long straight cirrhi of spores (Plate III).

Perithecia were opaque, narrowed at the ostiole, "250-340 x 160-262 microns." Spores were dark colored, distinctly triangular, 6.5-8.5 x 3.5-5.5 microns.

This species was distinctive in its straight unbranched hairs and its triangular spores. The author isolated this species

EXPLANATION OF PLATE III

Pure Cultures of:

Fig. 1. *Chaetomium gangligerum*

Fig. 2. *Chaetomium globosum*

Fig. 3. *Chaetomium indicum*

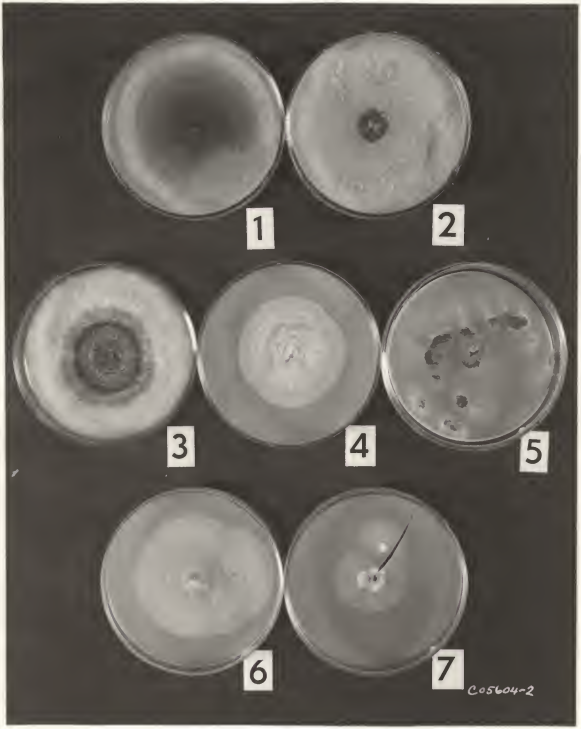
Fig. 4. *Chaetomium murorum*

Fig. 5. *Chaetomium olivaceum*

Fig. 6. *Chaetomium succineum*

Fig. 7. *Chaetomium trigonosporum*

PLATE III



from only one sample, although Skolko and Groves (34) reported this species had not been isolated from seed.

A single isolate was obtained from a sample of 1953 Cherokee grown in Kingman County in South Central Kansas.

Chaetomium murorum Corda. This species, as given by Skolko and Groves (34), possessed perithecia that were 240-300 x 240-300 microns, with a small, simple ostiole. Terminal hairs were dark-colored, smooth, about six microns wide, long undulate with graceful arches, ending in an open circinate, blunt tip. Spores were dark-colored, ellipsoid, slightly umbonate at one end, and measured 11.0-14.0 x 7.0-8.0 microns.

The long, undulate hairs with incurved tips and the ellipsoid spores distinctively aided in the identification of this species (Plate III). As shown by Table 2, it was isolated in only negligible amounts. This was apparently the first time this fungus had been reported from oat seed in Kansas.

It was noted that no isolates of Chaetomium murorum were found associated with 1951 seed samples. The comparative abundance of the fungus is shown in Table 14.

Table 14. Comparative samples of seed infected with Chaetomium murorum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
15	1950	Osage	Jewell	(NC)	6
30	1950	Cherokee	Saline	(C)	1
92	1952	Fulton	Sumner	(SC)	1
125	1953	Kanota	Marshall	(NE)	1

The next two species, Chaetomium olivaceum and Chaetomium globosum occurred in greater amounts than all other Chaetomium isolates.

Chaetomium olivaceum Cooke and Ellis. Chaetomium olivaceum (Plate III) was characterized by Skolko and Groves (34) as having globose perithecia which measured about 395 microns in diameter.

Terminal hairs were dark-colored, roughened, 3-5 microns wide, undulate, loosely interwoven. Spores were dark, broadly ovoid, umbonate at both ends, and measured 9.0-12.5 x 7.5-9.0 microns.

This was found to be the most prevalent of all species of Chaetomium. It made up 29.7 per cent of all the isolations for the four years, while the mean percentage of seeds infected with this species was 5.08 per cent which was shown in Table 2.

The comparative abundance of Chaetomium olivaceum is shown in Table 15.

In comparing the information given in Table 1 with the information in Table 15, it seemed to the author, that for the different years in general, Chaetomium olivaceum was much more ubiquitous in the wet years of 1950 and 1951. Also brought out in Table 15, was the decreasing amount of infection per sample in the years 1952 and 1953.

Table 15. Comparative samples of seed infected with Chaetomium olivaceum.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
1	1950	Kanota	Republic (NC)	20
2	1950	Kanota	Clay (NC)	1
3	1950	Kanota	Marion (C)	4
6	1950	Kanota	Cowley (SE)	95
7	1950	Kanota	Elk (SE)	91
8	1950	Fulton	Osborne (NC)	90
9	1950	Fulton	Jewell (NC)	52
10	1950	Fulton	Barton (C)	35
11	1950	Fulton	Kingman (SC)	39
18	1950	Osage	Reno (SC)	6
19	1950	Neosho	Mitchell (NC)	74
20	1950	Neosho	Cloud (NC)	37
24	1950	Neosho	Marshall (NE)	3
27	1950	Cherokee	Jewell (NC)	1
30	1950	Cherokee	Saline (C)	3
31	1950	Cherokee	Reno (SC)	1
33	1950	Cherokee	Pottawatomie (NE)	9
34	1950	Cherokee	Doniphan (NE)	2
38	1950	Cherokee	Elk (SE)	82
39	1950	Nemaha	Washington (NC)	2
40	1950	Nemaha	Jewell (NC)	19
41	1950	Nemaha	Ellsworth (C)	1
47	1950	Nemaha	Shawnee (EC)	2
48	1950	Nemaha	Franklin (EC)	1
53	1951	Neosho	Sedgwick (SC)	6
54	1951	Neosho	Marshall (NE)	3
55	1951	Neosho	Cowley (SE)	1
58	1951	Cherokee	Barton (C)	2
60	1951	Cherokee	Sumner (SC)	2
62	1951	Cherokee	Brown (NE)	4
66	1951	Cherokee	Crawford (SE)	2
67	1951	Cherokee	Butler (SE)	53
68	1951	Nemaha	Osborne (NC)	3
72	1951	Nemaha	Kingman (SC)	5
78	1951	Nemaha	Allen (SE)	1
87	1952	Kanota	Elk (SE)	1
98	1952	Cherokee	Republic (NC)	1
104	1952	Cherokee	Nemaha (NE)	2
117	1952	Nemaha	Osage (EC)	1
120	1952	Nemaha	Labette (SE)	13

Table 15 (concl.).

Sample No.	Year	Variety	Locality		Fungus percentage per sample
121	1953	Kanota	Dickinson	(C)	2
122	1953	Kanota	McPherson	(C)	1
149	1953	Nemaha	Stafford	(SC)	3
150	1953	Nemaha	Kingman	(SC)	1
152	1953	Nemaha	Jackson	(NE)	7
156	1953	Nemaha	Neosho	(SE)	9

Chaetomium globosum Kunze. Chaetomium globsum was reported by Skolko and Groves (34) as being a variable species, which could be confused with four other species of Chaetomium, but could be distinguished on the basis of the terminal hair characteristics and measurements and the size of the spores.

Perithecia were opaque, measuring 250-300 x 245-275 microns. The terminal hairs were light-colored, finely roughened, slender, about three microns wide, undulate below, becoming loosely coiled above, forming a dense interwoven mass. Spores were dark-colored, broadly ovoid, faintly apiculate at both ends, and measured 8.0-9.5 x 6.0-8.0 microns.

Chaetomium globosum (Plate III) closely resembled certain isolates of Chaetomium olivaceum but differed from the latter in having smaller perithecia, narrower hairs, and smaller spores. Chaetomium globosum was reported by Skolko and Groves (34) as having been isolated from oats grown in Ontario. Comparative abundance of Chaetomium globosum is shown in Table 16.

Table 16. Comparative samples of seed infected with Chaetomium globosum.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
2	1950	Kanota	Clay (NC)	12
3	1950	Kanota	Marion (C)	1
4	1950	Kanota	Russell (C)	1
5	1950	Kanota	Marshall (NE)	11
12	1950	Fulton	Sedgwick (SC)	11
13	1950	Fulton	Montgomery (SE)	7
42	1950	Nemaha	Barton (C)	1
45	1950	Nemaha	Doniphan (NE)	16
49	1950	Nemaha	Allen (SE)	10
53	1951	Neosho	Sedgwick (SC)	1
59	1951	Cherokee	Marion (C)	1
60	1951	Cherokee	Sumner (SC)	5
73	1951	Nemaha	Harvey (SC)	1
78	1951	Nemaha	Allen (SE)	9
79	1951	Nemaha	Butler (SE)	2
82	1952	Kanota	Dickinson (C)	10
83	1952	Kanota	McPherson (C)	1
88	1952	Fulton	Ottawa (NC)	27
91	1952	Fulton	Kingman (SC)	3
92	1952	Fulton	Sumner (SC)	2
94	1952	Osage	Reno (SC)	1
95	1952	Neosho	Russell (C)	33
99	1952	Cherokee	Dickinson (C)	1
100	1952	Cherokee	McPherson (C)	3
106	1952	Cherokee	Lyon (EC)	1
107	1952	Cherokee	Butler (SE)	1
109	1952	Nemaha	Republic (NC)	41
110	1952	Nemaha	Cloud (NC)	2
123	1953	Kanota	Reno (SC)	7
124	1953	Kanota	Harper (SC)	2
125	1953	Kanota	Marshall (NE)	2
127	1953	Fulton	Kingman (SC)	1
128	1953	Fulton	Sumner (SC)	4
134	1953	Cherokee	Jewell (NC)	3
135	1953	Cherokee	Russell (C)	1
136	1953	Cherokee	McPherson (C)	1
137	1953	Cherokee	Sedgwick (SC)	47
144	1953	Cherokee	Chautauqua (SE)	2

In comparing samples infected with Chaetomium olivaceum in Table 15, with samples infected with Chaetomium globosum in Table 16, it seemed to the author that except for a few samples, where one occurred the other did not and vice versa.

This species of Chaetomium was second only to Chaetomium olivaceum in abundance, since it made up 10.7 per cent of all the isolates. The mean percentage of infection of seed samples was 1.83 per cent, which was shown in Table 2.

Chaetomium aureum Chivers. Skolko and Groves (34) described Chaetomium aureum as being representative of a section of the genus in which the perithecia were small and the terminal hairs arcuate, usually incurving. Spores were unevenly ellipsoid, flattened on one side, faintly apiculate at one or both ends, dark-colored, 8.5-11.0 x 4.5-5.5 microns.

This species occurred only once, being isolated from 1951 Nemaha grown in Osborne County in North Central Kansas.

The only isolate of this species became contaminated with Aspergillus niger, which prevented making a photographic recording of the mycelial growth.

Chaetomium succineum Ames. Perithecia were opaque, globose, about 260 microns in diameter. Terminal hairs of this species placed it in the group with hairs having three to seven coils, according to the key suggested by Skolko and Groves (34). Spores were dark-colored, ellipsoid, rounded at both ends, 12-15 x 7.5-8.5 microns.

Chaetomium succineum (Plate III) was characterized by the slender, coiled terminal hairs and large ellipsoid spores. It differed from Chaetomium globosum which had lemon-shaped spores and from Chaetomium murorum which had stout circinate terminal hairs.

Chaetomium succineum was reported by Skolko and Groves (34) as having been isolated from vegetable seeds, but not from cereal seed. This was the first time this fungus had been reported from oat seed as far as the author could determine.

This species occurred only once, that being the 1950 Neosho oats grown in Harvey County in South Central Kansas.

Chaetomium atrosporium Skolko and Groves. The distinctive characteristics of this species were described by Skolko and Groves (34), wherein the terminal hairs were irregularly sinuous, long, untapered, occasionally branched at right angles, and from 3 to 3.5 microns in thickness. The asci were 8-spored, stout, and measured 44 x 23 microns. Spores were globose to subglobose, often flattened on one side, dark brown, 14.5-15.5 x 13.0-14.5 microns, and were provided with two distinct pores. Chaetomium atrosporium was easily distinguished by the large dark-colored spores not found in any other species.

No reports were found on this fungus, as having been isolated from oats previous to this study.

One isolate (Plate II) of this species, occurred in 1953 Neosho seed, grown in Morris County in East Central Kansas.

Chaetomium cristatum Ames. According to Skolko and Groves (34), the wide ostiole, broad untapered, erect terminal hairs with irregularly branched or short coiled tips and ellipsoid spores distinguish Chaetomium cristatum from all other species. Spores were ellipsoid, umbonate to subapiculate, olive brown, 8-12 x 4.5-6 microns.

One isolate (Plate II) of this species occurred in 1950 Osage grown in Rice County, in Central Kansas.

Chaetomium gangligerum Ames. According to the key furnished by Skolko and Groves (34), this species belonged to that group possessing terminal hairs with three to seven spiral coils (Plate III).

Perithecia were subglobose to ovoid "230-260 x 190-210 microns." Spores were dark-colored, ovoid ellipsoid, rounded on the ends or faintly umbonate, and measured 10-13 x 7-8.5 microns. This species has not been reported from seed in the literature. As shown in Table 17, Chaetomium gangligerum was isolated from two samples of 1951 seed and a single sample of 1953 seed.

Table 17. Comparative samples of seed infected with Chaetomium gangligerum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
66	1951	Cherokee	Crawford	(SE)	1
69	1951	Nemaha	Mitchell	(NC)	2
139	1953	Cherokee	Marshall	(NE)	1

Chaetomium bostrychodes Zopf. The perithecia of this species, according to Skolko and Groves (34) were subglobose to ovoid, 200-260 x 170-195 microns, and were provided with a distinct collar around the ostiole and were easily visible in young perithecia. Terminal hairs were straight below, spirally coiled above with six to eight coils of diminishing diameter, and less than five microns at the base. Spores were broadly oval, faintly apiculate at both ends, light-colored, and measured 7.0-8.5 x 6.0-7.0 microns. Skolko and Groves (34) reported receiving a culture of this species isolated from oat seed in Ireland. Seven samples of

Kansas oat seed contained isolates of this species (Plate II) and are shown in Table 18. It was also noted that these seed samples were obtained primarily from the East Central and North Eastern agricultural divisions of the state.

This study was the first recording of this species from oats grown in Kansas.

Table 18. Comparative samples of seed infected with Chaetomium bostrychodes.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
47	1950	Nemaha	Shawnee	(EC)	1
64	1951	Cherokee	Shawnee	(EC)	1
102	1952	Cherokee	Kingman	(SC)	1
112	1952	Nemaha	Ellsworth	(C)	1
115	1952	Nemaha	Brown	(NE)	1
139	1953	Cherokee	Marshall	(NE)	2
142	1953	Cherokee	Osage	(EC)	1

Chaetomium brasiliense Batista and Pontual. The author tentatively identified this isolate as Chaetomium brasiliense, pending verification by Groves. It was the opinion of the author that all characteristics of these isolates fit but for one mentioned by Skolko and Groves (34), specifically the monostichus arrangement of the spores in the ascus, which they said was difficult to observe.

According to Dr. Groves' letter of September 13, 1954, he agreed that in the clustered condition of the ascospores in the asci, the isolate did not fit Chaetomium brasiliense and pointed out that the large size of the perithecia also was a difference. Dr. Groves and Dr. Hughes believed that it was an undescribed species. However, Dr. Skolko thought that it might be close enough to Chaetomium brasiliense to call it that.

The general characteristics noted by Skolko and Groves (34) were the small perithecia, which measured 90-120 x 75-90 microns and were dark-colored. The narrow coiled terminal hairs and the broadly ovoid spores, apiculate at only one end.

Isolates of this species were found in seven samples of oat seed. The outstanding thing about these isolates was the fact that all occurred through the central agricultural divisions of the state, from South Central through North Central.

Chaetomium brasiliense (Plate II) was not obtained in any of the 1952 samples of seed, while the greatest number of isolates occurred in 1953 samples of seed. The comparative abundance of this species is shown in Table 19.

Table 19. Comparative samples of seed infected with Chaetomium brasiliense.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
30	1950	Cherokee	Saline	(C)	1
71	1951	Nemaha	Sedgwick	(SC)	1
124	1953	Kanota	Harper	(SC)	1
127	1953	Fulton	Kingman	(SC)	1
134	1953	Cherokee	Jewell	(NC)	1
146	1953	Nemaha	Ottawa	(NC)	1
149	1953	Nemaha	Stafford	(SC)	1

Chaetomium spp. In all, there were 20 isolates of Chaetomium from 18 samples, that the author was unable to identify to species. Characteristics of the mycelium and the perithecia made these isolates fall unmistakably into the genus Chaetomium. The identification of this group was restricted by the immaturity of the fruit bodies.

Sordariaceae. This family is of little importance from an economic standpoint.

According to Cain and Groves (6), members of this family are saprobes occurring on dung or on decaying plant parts.

Sordaria fimicola (Rob) Ces. and De Not. The genus Sordaria, according to Cain and Groves (6), should ultimately be divided into several genera that would include species with natural affinities. It was their opinion, that an attempt should be made to establish the status of the various generic names. The genus was reported as isolated in trace amounts from cereal seed, by Machacek et al. (25), in the Canadian studies.

Sordaria fimicola is reportedly quite often found on dung, and frequently occurs on other substrates, such as decaying vegetation; for that reason it was not surprising to find that this species represented 5.4 per cent of all the isolates.

The mycelium of Sordaria fimicola produced a rapid and luxuriant growth on potato dextrose agar (Plate IV). It seemed quite reasonable to the author that other fungi that might be present in seeds plated on the same plate, might have quite often been inhibited by the aggresiveness of this fungus to utilize the available nutrition present in the plate.

Numerous pyriform perithecia were produced in a superficial layer. The outer wall was bare except at the point of attachment, where the hyphae attached the perithecium to the substratum.

EXPLANATION OF PLATE IV

Pure Cultures of:

Fig. 1. _Thielavia terricola_

Fig. 2. _Microascus cirrosus_

Fig. 3. _Sordaria fimicola_

Fig. 4. _Sordaria humana_

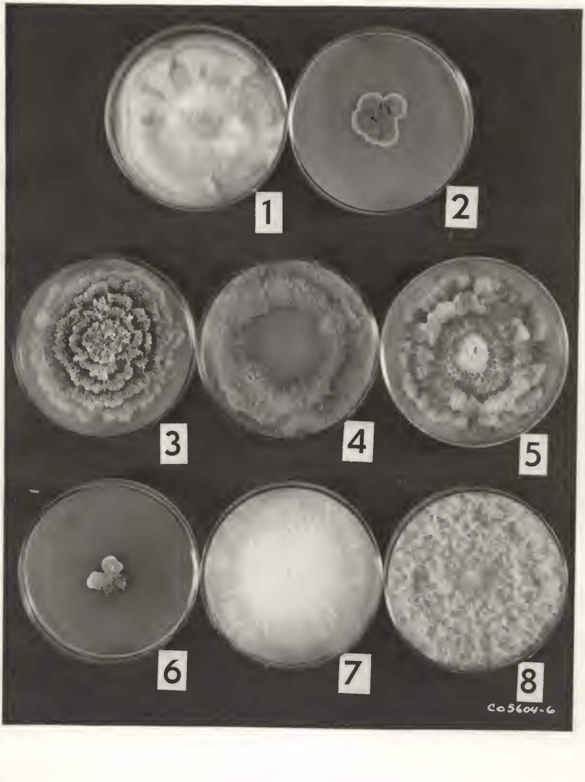
Fig. 5. _Sordaria anserina_

Fig. 6. _Sporormia australis_

Fig. 7. _Rosellinia sp._

Fig. 8. _Melanospora zamiae_

PLATE IV



The asci were born in a single palisade-like layer attached at the base. The spores were obliquely uniseriate, dark brown to near black, ellipsoid, with a circular germ pore at the lower end; measurements were generally 23-24 x 12-14 microns. Comparative abundance of Sordaria fimicola is shown in Table 20.

It seemed quite apparent to the author that there was a very noticeable trend for Sordaria fimicola to be present in more samples of 1950 and 1951 oat seed, than in samples of 1952 and 1953 seed when comparing the availability of seed samples in Table 1.

Table 20. Comparative samples of seed infected with Sordaria fimicola.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
2	1950	Kanota	Clay	(NC)	1
3	1950	Kanota	Marion	(C)	1
4	1950	Kanota	Russell	(C)	1
5	1950	Kanota	Marshall	(NE)	3
10	1950	Fulton	Barton	(C)	1
11	1950	Fulton	Kingman	(SC)	2
12	1950	Fulton	Sedgwick	(SC)	1
14	1950	Fulton	Elk	(SE)	2
15	1950	Osage	Jewell	(NC)	1
16	1950	Osage	Rice	(C)	3
17	1950	Osage	Kingman	(SC)	1
20	1950	Neosho	Cloud	(NC)	3
22	1950	Neosho	Reno	(SC)	1
24	1950	Neosho	Marshall	(NE)	4
26	1950	Neosho	Cowley	(SE)	1
31	1950	Cherokee	Reno	(SC)	2
32	1950	Cherokee	Sumner	(SC)	2
34	1950	Cherokee	Doniphan	(NE)	1
38	1950	Cherokee	Elk	(SE)	1
42	1950	Nemaha	Barton	(C)	1
44	1950	Nemaha	Kingman	(SC)	1
47	1950	Nemaha	Shawnee	(EC)	3
49	1950	Nemaha	Allen	(SE)	1

Table 20 (concl.).

Sample No.	Year	Variety	Locality	Fungus percentage per sample
52	1951	Neosho	Kingman (SC)	4
53	1951	Neosho	Sedgwick (SC)	4
55	1951	Neosho	Cowley (SE)	4
56	1951	Cherokee	Republic (NC)	6
57	1951	Cherokee	Smith (NC)	2
58	1951	Cherokee	Barton (C)	5
59	1951	Cherokee	Marion (C)	3
60	1951	Cherokee	Sumner (SC)	3
61	1951	Cherokee	Sedgwick (SC)	3
63	1951	Cherokee	Nemaha (NE)	4
64	1951	Cherokee	Shawnee (EC)	8
66	1951	Cherokee	Crawford (SE)	1
67	1951	Cherokee	Butler (SE)	2
69	1951	Nemaha	Mitchell (NC)	2
71	1951	Nemaha	Sedgwick (C)	1
72	1951	Nemaha	Kingman (SC)	4
73	1951	Nemaha	Harvey (SC)	7
74	1951	Nemaha	Brown (NE)	2
75	1951	Nemaha	Jackson (NE)	4
76	1951	Nemaha	Wabaunsee (EC)	6
77	1951	Nemaha	Morris (EC)	1
78	1951	Nemaha	Allen (SE)	1
79	1951	Nemaha	Butler (SE)	7
86	1952	Kanota	Cowley (SE)	1
88	1952	Fulton	Ottawa (NC)	1
91	1952	Fulton	Kingman (SC)	1
93	1952	Osage	Rice (C)	1
97	1952	Cherokee	Cloud (NC)	1
102	1952	Cherokee	Kingman (SC)	1
114	1952	Nemaha	Sedgwick (SC)	1
115	1952	Nemaha	Brown (NE)	1
116	1952	Nemaha	Jackson (NE)	1
117	1952	Nemaha	Osage (EC)	1
133	1953	Cherokee	Clay (NC)	1
134	1953	Cherokee	Jewell (NC)	2
139	1953	Cherokee	Marshall (NE)	1
144	1953	Cherokee	Chautauqua (SE)	1
146	1953	Nemaha	Ottawa (NC)	1
151	1953	Nemaha	Brown (NE)	2
153	1953	Nemaha	Osage (EC)	1
154	1953	Nemaha	Morris (EC)	4

Sordaria humana (Fuckel) Winter. This species closely resembled *Sordaria fimicola*, but could be distinguished by means of the spores which were distinctly broader in proportion to their length. Cain and Groves (6) reported the measurements as being 22-28 x 16-19 microns (Plate IV).

Sordaria humana occurred only once in 1951 Nemaha seed harvested in Kingman County, in South Central Kansas.

Sordaria anserina (Cesati) Winter. At the time of isolation, the author was unable to identify this sample to species. The isolate was determined by Dr. R. F. Cain, University of Toronto (Plate IV).

As characterized by Cain and Groves (6), the perithecia were pyriform and measured 450-460 x 325-375 microns. The perithecia were covered with small black tubercles. Asci were 4-spored and measured 240-280 x 19-23 microns. Ascospores were ellipsoid 34-40 x 18-20 microns; primary appendages (not seen by the author) were cylindrical, 25-30 x 5 microns; secondary appendages according to Dr. Cain were about 75 microns long, curved, the upper was about 8 microns wide at the base and attached eccentrically to the apex of the spore; the lower appendages were about 5 microns wide.

Only one sample of this species was isolated from oat seed. It was found in a sample of 1952 Cherokee seed harvested in Republic County in North Central Kansas.

Sporormia. The genus Sporormia, as given by Gilman (13), was characterized by the perithecia being globose, sunken or less frequently superficial, with a rather cylindric beak, sometimes slightly brittle. The asci were cylindric with an internal membrane, which was usually perforate at the apex. Spores were cylindric, three to many spetate, usually dark brown and opaque and surrounded by a hyaline gelatinous envelope. Three species of Sporormia were isolated from oat seed grown in Kansas.

Sporormia australis Speg. In this species (Plate IV), spores were 4-celled, dark, in two or more series, less than 45 microns and over 35 microns in length. Asci were cylindrical and contracted abruptly below. Spores ranged 40-41 x 7-8 microns, and the asci were approximately 140 x 14 microns. The author referred to the characterization given by Cain (5) for the identification of this species.

Sporormia australis made up 0.5 per cent of all the isolates from oat seed. The comparative abundance of this fungus is shown in Table 21. There was no indication of this fungus appearing in noticeable amounts in any one sample or any one year.

The author found no record of this fungus as having been isolated from oat seed prior to this study.

Sporormia intermedia Auersw. Spores of this species were 4-celled, dark, in two or more series, and over 45 microns in length. Spore measurements ranged 52-58 x 10 microns and the asci measured 70 x 17 microns. This species occurred in one sample of each of the four years, as shown in Table 22.

Table 21. Comparative samples of seed infected with Sporormia australis.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
26	1950	Neosho	Cowley	(SE)	1
32	1950	Cherokee	Sumner	(SC)	2
59	1951	Cherokee	Marion	(C)	1
63	1951	Cherokee	Nemaha	(NE)	3
92	1952	Fulton	Sumner	(SC)	1
102	1952	Cherokee	Kingman	(SC)	1
103	1952	Cherokee	Brown	(NE)	2
120	1952	Nemaha	Labette	(SE)	1
156	1953	Nemaha	Neosho	(SE)	1

Table 22. Comparative samples of seed infected with Sporormia intermedia.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
47	1950	Nemaha	Shawnee	(EC)	1
66	1951	Cherokee	Crawford	(SE)	1
90	1952	Fulton	Barton	(C)	1
124	1953	Kanota	Harper	(SC)	1

Sporormia minima Auersw. Spores were 4-celled, dark, in two or more series, less than 35 microns (31-32 x 5.6 microns). The asci measured approximately 105 x 12 microns. This species also occurred in only trace amounts and was found in only two samples, which are shown in Table 23.

Table 23. Comparative samples of seed infected with Sporormia minima.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
56	1951	Cherokee	Republic	(NC)	1
102	1952	Cherokee	Kingman	(SC)	1

Melanosporaceae. According to Bessey (4), the perithecia of the Melanosporaceae are light brown, rarely colorless, thin-walled, and may be superficial or sunk in a subiculum. There are no paraphyses. The dark-colored ascopores are discharged through the ostiole at maturity.

Melanospora zamiae Corda. Melanospora zamiae was identified from the characteristics given by Mason (26).

The perithecia were globose, translucent red, yellow or golden, and surrounded by a weft of mycelium (Plate IV). The ostiolate perithecia were 160-300 microns in diameter. The ostiole measured from 170 to 475 microns in length. Asci were clavate 60-70 x 28-35 microns and 8-spored. The black ascospores were broad fusoid and measured 16-24 x 11-18 microns.

A single isolate was identified from only one sample of oat seed, which was 1952 Kanota grown in Elk County in the Southeastern section of the state.

Xylariaceae. According to Alexopoulos (1), the Xylariaceae are considered the most typical family of the Sphaeriales. Members of this family have well-developed stromata composed entirely of fungal tissue in which perithecia with definite walls are embedded, with their necks slightly protruding.

Rosellinia limoniispora Ell. and Ev. The author was able to identify isolates of this fungus only to genus. The mycelium was characteristically a deep concentrated white, with black fruiting bodies sparsely arranged on the mycelial mat (Plate IV).

The ascocarps were extremely large; sometimes attaining up to one millimeter in diameter. Ascospores were black, elliptical, citriforme, and measured 6.9-10.2 x 13.8-17.5 microns.

Dr. Roy F. Cain, of the University of Toronto, identified this fungus to species.

There were no isolates of this fungus associated with any of the 1950 oat seed samples, but the other samples infected are shown in Table 24.

Table 24. Comparative samples of seed infected with Rosellinia limoniispora.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
69	1951	Nemaha	Mitchell	(NC)	1
74	1951	Nemaha	Brown	(NE)	1
75	1951	Nemaha	Jackson	(NE)	1
81	1952	Kanota	Republic	(NC)	1
91	1952	Fulton	Kingman	(SC)	1
134	1953	Cherokee	Jewell	(NC)	1
139	1953	Cherokee	Marshall	(NE)	1

DEUTEROMYCETES

The Deuteromycetes are those fungi known to have septate mycelium and which, so far as anyone has discovered, reproduce only by means of conidia.

The Deuteromycetes may be conidial stages of Ascomycetes, or more rarely, Basidiomycetes, whose sexual stages have not been discovered or no longer exist.

According to Alexopoulos (1), the artificial system is purely a matter of convenience which enables workers to identify the conidial stages of many known Ascomycetes (some of which form their ascocarps but once a year).

Sphaeropsidales

The Sphaeropsidales are characterized by means of conidia borne in pycnidia.

Sphaeropsidaceae. As described by Alexopoulos (1), the pycnidia of Sphaeropsidaceae are dark-colored, leathery to carbonous, generally (but not always) supplied with a circular opening.

Pyrenochaeta sp. This fungus was identified to genus on the basis of the description given by Gilman (13), but the author was unable to identify this isolate to species.

This isolate produced a black, radiating, slimy, mycelial mat and gray, fluffy, aerial mycelium. The hyphae was united in black strands.

Pycnidia were spherical, flask-shaped, erumpent, carbonous, black with stiff, simply setae chiefly at the top.

Spores were hyaline to fuscous one-celled, and measured 1.5-4 x 1.5 microns, while in shape they were cylindric-ellipsoid to pip-shaped.

A single colony of this fungus was isolated from a sample of 1951 Cherokee harvested in Nemaha County, in the Northeastern agricultural section of the state.

Phoma sp. In this isolate, pycnidia were globose to lens-shaped, with small papilla at the apex, almost carbonous, black (Plate V). Conidia were wavy oblong and cylindric, fuscous, 10-15 x 4-5 microns. Gilman (13) made mention of the spores usually with two oil drops, which this author was unable to determine.

A single isolate of this genus was found from 1950 Kanota seed grown in Marion County, in the Central division of Kansas.

Moniliales

The Moniliales produced conidia not borne in a pycnidium or acervuli.

Dematiaceae. The fungi belonging to the form-family Dematiaceae were given by Alexopoulos (1), as those whose hyphae and the conidia are typically dark, but sometimes the hyphae alone or the conidia only are dark.

Alternaria Tenuis auct. sensu Wiltshire. In an effort to establish other species of this genus, the author referred to the work of Neergaard (30), and Groves and Skolko (16), but was unable to justify any other species than Alternaria tenuis in

EXPLANATION OF PLATE V

Pure Cultures of:

Fig. 1. *Phoma sp.*

Fig. 2. *Alternaria tenuis*

Fig. 3. *Curvularia geniculata*

Fig. 4. *Helminthosporium sativum*

Fig. 5. *Helminthosporium tetramera*

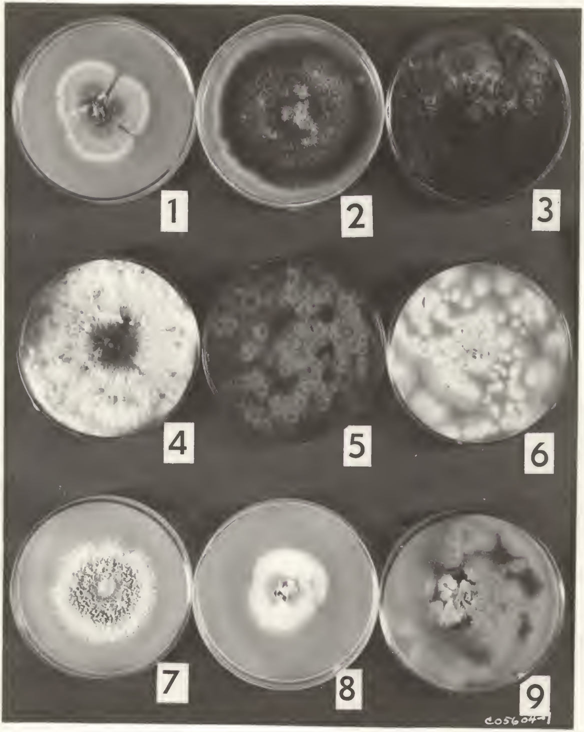
Fig. 6. *Periconia sp.*

Fig. 7. *Nigrospora sphaerica*

Fig. 8. *Cephalosporium asperum*

Fig. 9. *Sporotrichum roseolum*

PLATE V



this group (Plate V).

Sprague (37) stated:

> Most of the saprophytic black molds referred to Alternaria spp. on grass and cereals are now placed in Alternaria tenuis. This species is generally recognized but it has no type specimen and no legal status even though it is relatively certain of being accepted permanently as a good species.

On potato dextrose agar, there was abundant production of greenish to dark olivaceous mycelium. Conidiophores were brown septate, simple, sometimes branched and 3-6 microns in diameter. Conidia were generally a dark brown, usually three to five cross walls, obclavate with rather short beaks and borne in long chains, 18-20 x 9-16 microns.

The comparative abundance of Alternaria tenuis for the four-year period is shown in Table 25.

One outstanding feature which is shown in Table 25 was the abundance of this fungus in the 1953 samples over the previous samples. This seemed to substantiate the fact that some fungi die out with the age of the seed.

The occurrence of this fungus seemed to be quite general for all the divisions involved in this study of oat seed, except in individual samples where infection was heavy.

The greatest infection occurring in a single sample, occurred in a sample of 1953 Cherokee harvested in Russell County in the Central division. In this sample 67 per cent of the seeds were infected with Alternaria tenuis and only 7 per cent of the seeds showed any germination.

The author found this fungus to represent 17.8 per cent of the total number of isolations.

Table 25. Comparative samples of seed infected with Alternaria tenuis.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
9	1950	Fulton	Jewell (NC)	1
12	1950	Fulton	Sedgwick (SC)	1
29	1950	Cherokee	McPherson (C)	1
54	1951	Neosho	Marshall (NE)	1
61	1951	Cherokee	Sedgwick (SC)	1
62	1951	Cherokee	Brown (NE)	2
67	1951	Cherokee	Butler (SE)	3
69	1951	Nemaha	Mitchell (NC)	3
70	1951	Nemaha	Dickinson (C)	3
72	1951	Nemaha	Kingman (SC)	8
75	1951	Nemaha	Jackson (NE)	1
82	1952	Kanota	Dickinson (C)	4
84	1952	Kanota	Kingman (SC)	1
87	1952	Kanota	Elk (SE)	14
92	1952	Fulton	Sumner (SC)	2
99	1952	Cherokee	Dickinson (C)	1
100	1952	Cherokee	McPherson (C)	2
119	1952	Nemaha	Butler (SE)	1
121	1953	Kanota	Dickinson (C)	41
122	1953	Kanota	McPherson (C)	13
123	1953	Kanota	Reno (SC)	40
125	1953	Kanota	Marshall (NE)	6
126	1953	Kanota	Cowley (SE)	17
127	1953	Fulton	Kingman (SC)	10
128	1953	Fulton	Sumner (SC)	40
129	1953	Fulton	Cowley (SE)	41
132	1953	Neosho	Cowley (SE)	13
133	1953	Cherokee	Clay (NC)	6
134	1953	Cherokee	Jewell (NC)	6
135	1953	Cherokee	Russell (C)	67
136	1953	Cherokee	McPherson (C)	1
137	1953	Cherokee	Sedgwick (SC)	3
142	1953	Cherokee	Osage (EC)	3
144	1953	Cherokee	Chautauqua (SE)	14
145	1953	Nemaha	Jewell (NC)	14
146	1953	Nemaha	Ottawa (NC)	5
147	1953	Nemaha	Ellsworth (C)	7
148	1953	Nemaha	Barton (C)	6
150	1953	Nemaha	Kingman (SC)	4
151	1953	Nemaha	Brown (NE)	32
153	1953	Nemaha	Osage (EC)	4
155	1953	Nemaha	Elk (SE)	27
156	1953	Nemaha	Neosho (SE)	5

Curvularia geniculata (Tracy and Earle) Boedijn. This was another of the dematiaceous fungi. Isolates of this species produced a luxuriant dark gray to nearly black, more or less stringy growth, with an abundant production of spores (Plate V). Spores were three- to five-celled, brown, fusiform, typically curved or bent, with the third cell from the base slightly larger and darker. Spores measured 24-26 x 11-14 microns.

Groves and Skolko (17) reported this species from cabbage, flax, and pea seed. According to Sprague (37), Curvularia geniculata is sort of a catch-all, and the classification outlined by Groves and Skolko is still likely to be changed by future investigations. It was Sprague's opinion, that the differences in the species of Curvularia are justified but difficult for the routine worker to follow. Curvularia geniculata has been isolated from the roots and seeds of all commercially-grown cereals. Sprague further stated, that in tests, isolates of Curvularia geniculata have proven to be more pathogenic than Helminthosporium sativum.

No isolates of this species were obtained from 1950 oat seed. The samples infected with this fungus are shown in Table 26.

Curvularia geniculata was found to represent 0.5 per cent of the isolates from Kansas grown oat seed.

Helminthosporium sativum P. K. B. This fungus, as stated by Sprague (37), "causes a dark brown seedling rot of the coleoptile region, a spot blotch on the leaves, spikes and seed, and a root or crown rot of maturing plants."

Table 26. Comparative samples of seed infected with Curvularia geniculata.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
67	1951	Cherokee	Butler	(SE)	1
87	1952	Kanota	Elk	(SE)	1
129	1953	Fulton	Cowley	(SE)	2
132	1953	Neosho	Cowley	(SE)	1
135	1953	Cherokee	Russell	(C)	4
151	1953	Nemaha	Brown	(NE)	1
155	1953	Nemaha	Elk	(SE)	4

Isolates from oats, produced a velvety layer of gray to olive black mycelium on potato dextrose agar (Plate V). The spore characteristics of this species seemed to be quite variable.

To definitely identify isolates of this fungus to species, the author employed the "hanging drop technique." A drop of spore suspension was placed on a cover slip, which was then inverted and sealed with petroleum jelly on glass cylinders placed on slides. After exposure to room temperature for a period of about five hours, it was possible to positively determine whether germination of the spores was polar or lateral. A distinguishing feature of this species, and the group to which it belongs, is the fact that all of the spores of this group had polar germination. The spores from oat isolates measured 47.6-92 x 13.6-23.8 microns, which was a normal range for Helminthosporium sativum, according to the key of Luttrell (23).

There were no colonies of Helminthosporium sativum found associated with any 1950 or 1952 oat samples. Comparative abundance of this species is shown in Table 27. The greatest single infection of a sample was recorded from a sample of 1951 Nemaha harvested in Kingman County in South Central Kansas, in which only 5 per cent of the seeds were infected.

Helminthosporium sativum occurred in 0.4 per cent of the total isolations from oats grown in Kansas.

Table 27. Comparative samples of seed infected with *Helminthosporium sativum*.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
51	1951	Neosho	Barton	(C)	1
54	1951	Neosho	Marshall	(NE)	1
72	1951	Nemaha	Kingman	(SC)	5
79	1951	Nemaha	Butler	(SE)	1
123	1953	Kanota	Reno	(SC)	2
135	1953	Cherokee	Russell	(C)	2

Helminthosporium tetramera McKinney. On potato dextrose agar, the mycelium of *Helminthosporium tetramera* was slightly aerial and generally a very concentrated olive black (Plate V). Conidiophores were dark olivaceous, simple or compound, with conidia produced at irregular intervals. Isolates from oats agreed without exception as to spore characteristics, with the description given by Sprague (37). They were dark olive-smoky, relatively thin-walled, regularly elongate, elliptical, 3-septate, 23-31 x 8-12 microns, borne on simple or sparsely-branched conidiophores.

This species was not isolated from any of the 1950 oat samples. The comparative abundance of *Helminthosporium tetramera* is shown in Table 28.

This species was found to be equally as prevalent as *Helminthosporium sativum*, inasmuch as it also made up 0.4 per cent of the total isolates, although it was present in more samples. It should be stated, however, that neither of these fungi were found in any 1950 samples. *Helminthosporium tetramera*, as shown in Table 28, was found to be much more prevalent in a single sample of 1953 Cherokee grown in Chautauqua County, in Southeastern Kansas.

Table 28. Comparative samples of seed infected with *Helminthosporium tetramera*.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
67	1951	Cherokee	Butler (SE)	1
69	1951	Nemaha	Mitchell (NC)	1
72	1951	Nemaha	Kingman (SC)	1
82	1952	Kanota	Dickinson (C)	1
128	1953	Fulton	Sumner (SC)	1
135	1953	Cherokee	Russell (C)	1
144	1953	Cherokee	Chautauqua (SE)	4
147	1953	Nemaha	Ellsworth (C)	1
148	1953	Nemaha	Barton (C)	1

Helminthosporium spp. Only two samples of Helminthosporium were unidentifiable as to species. Both of these failed to reach complete maturity although immature spores definitely indicated by their septation and dimensions that they were species of Helminthosporium.

Periconia igniaria Mason and M. B. Ellis. According to the description given in British Species of Periconia by Mason and Ellis (27), conidia are typically catenulate or occasionally single, globose, one-celled, brown, nearly always rough-walled, lacking any obvious hilum, produced both from mycelial hyphae and from macronematous conidiophores (Plate V). Conidial chains are often branched, usually originating from recognizable sporogenous cells, developing in acropetal succession but usually maturing from the apex backwards.

Only one isolate of this fungus was found to be associated with oat seed. This was found in a sample of 1951 Nemaha from Jackson County.

Stemphylium botryosum Wallroth. Colonies isolated from oat seed were very dark and floccose spreading (Plate VI). Conidiophores were olive brown, variable in length, swollen at the apex just below the attachment of the spore. According to Sprague (37), sometimes the terminal spore becomes pushed to one side by the continued growth of the conidiophore. Conidia were oblong, dark brown, rough-walled, constricted at the medium septum, packet-shaped or sarcinae form, with transverse, longitudinal, and oblique septa, 18-35 x 15-22 microns, borne singly at the end of the conidiophores. Sprague (37) reported *Stemphylium botryosum* as being a saprophyte, but much less prevalent than *Alternaria tenuis*.

Groves and Skolko (15) obtained perithecia primordia, which were hard and black, when they grew this fungus on malt extract agar.

EXPLANATION OF PLATE VI

Pure Cultures of:

Fig. 1. *Botrytis sp*.

Fig. 2. *Papularia sphaeroperma*

Fig. 3. *Mycogone nigra var*. *minor*

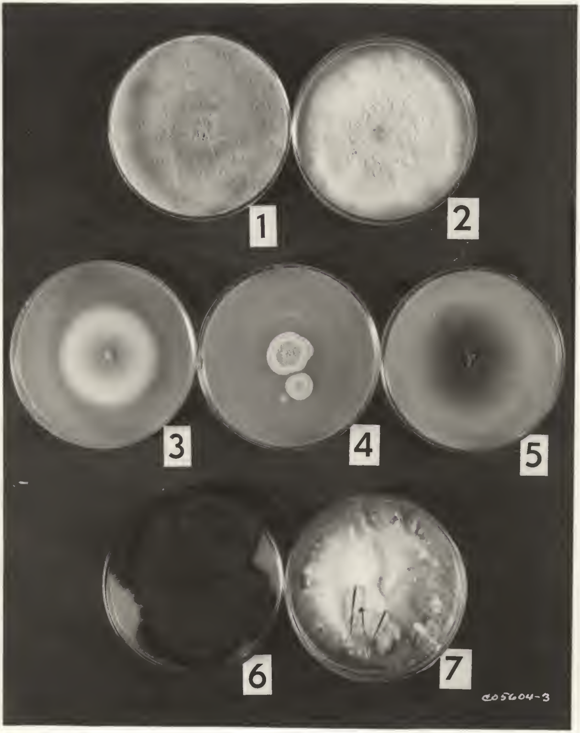
Fig. 4. *Scopulariopsis brevicaulis*

Fig. 5. *Pullularia pullulans*

Fig. 6. *Stemphylium botryosum*

Fig. 7. *Isaria sp*.

PLATE VI



The comparative abundance of Stemphylium botryosum is shown in Table 29. It should be noted that no isolates were obtained from 1951 or 1952 seed samples.

Table 29. Comparative samples of seed infected with Stemphylium botryosum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
15	1950	Osage	Jewell	(NC)	1
123	1953	Kanota	Reno	(SC)	2
146	1953	Nemaha	Ottawa	(NC)	1
151	1953	Nemaha	Brown	(NE)	1
155	1953	Nemaha	Elk	(SE)	1

Moniliaceae. Alexopoulos (1) described this form family as being the largest of all in the Moniliales. It includes all imperfect fungi which produce conidia on hyaline conidiophores, or directly on the somatic hyphae.

Aspergillus. The following Aspergilli were those that had no perfect stage, therefore they were not considered with the Ascomycetes.

Aspergillus restrictus G. Smith. This isolate grew very poorly on Czapek's agar. At first it was a dark dull green, velvety; then it became wrinkled (Plate 1). Heads formed long, compact, slender columns up to 350 microns by 20 to 30 microns in diameter. Conidiophores generally arose from the substratum, but sometimes from aerial hyphae, smooth and sinuous, uncolored. Vesicles were flask-shaped, sterigmata were in one series, borne on the upper surface of the vesicles only.

According to Thom and Raper (38), conidia were rough, somewhat pyriform, a dark greenish brown, and measured 4 to 6.5 microns by 3-4 microns; perithecia were not formed.

This species occurred only once in a sample of 1951 Cherokee from Brown County in Northeastern Kansas.

Aspergillus terreus Thom. Colonies on Czapek's agar grew well at room temperature and spread rather evenly over the plate (Plate I). The colony was velvety, with heavy sporulation throughout. According to Thom and Raper (38), the massed columnar heads were responsible for the characteristic color and texture. Color ranged from a light cinnamon shade to a deeper light brown. Conidial heads were long and columnar, with conidial chains compacted together; they were of uniform diameter throughout the entire length and commonly ranged from 150 to 500 microns by 30 to 50 microns at maturity.

This species occurred only once in one oat seed sample which was 1952 Neosho grown in Reno County in South Central Kansas.

Aspergillus wentii Wehmer. According to Thom and Raper (38), "Aspergillus wentii is a cosmopolitan species that is fairly common in soils, upon moist grains and other vegetable matter undergoing slow decomposition."

Colonies of this species were characterized by their rapid and broadly spreading growth (Plate I). Thom and Raper (38) described some strains that were floccose with white or aerial hyphae which (in some strains) piled up in the plate, but remained inconspicuous in other strains. The author found the latter to be true in the isolations from oats.

In this imperfect species, the heads were at first white through yellow shades, becoming reddish-brown in older cultures. The conidiophore walls were colorless and up to 4 microns in thickness. Vesicles were globose and fertile over the entire surface.

The three samples infected with this species are shown in Table 30.

Table 30. Comparative samples of seed infected with Aspergillus wentii.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
2	1950	Kanota	Clay	(NC)	2
61	1951	Cherokee	Sedgwick	(SC)	2
112	1952	Nemaha	Ellsworth	(C)	1

Aspergillus spp. There were a few isolates of the genus Aspergillus that the author was unable to identify to species because colonies were contaminated or failed to reach maturity. In all, the unidentified species represented 0.4 per cent of the total isolates.

Botrytis sp. Colonies on Czapeks agar were at first flat brown to rose, later grading into the brown-black range (Plate VI). The mycelium was appressed and prostrate, with the conidiophores having the appearance of emerging from the agar surface; conidiophores erect, septate and definitely branched, giving the appearance of whorls. Conidia were somewhat fusiforms and flattened on one side, borne terminally in cluster, 2-3 x 5-6 microns, appearing pale yellow in color.

Macroscopically this fungus appeared to be a species of Sporotrichum, but upon closer examination proved to be slightly more appressed and not as aerial as in Sporotrichum.

The samples from which it was isolated are shown in Table 31.

Table 31. Comparative samples of seed infected with Botrytis sp.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
24	1950	Neosho	Marshall	(NE)	1
47	1950	Nemaha	Shawnee	(EC)	3
75	1951	Nemaha	Jackson	(NE)	1
77	1951	Nemaha	Morris	(EC)	1

Cephalosporium asperum Marchal. As reported by Gilman (13), colonies had a grayish buff tan appearance; sterile hyphae were prostrate, branching, sparingly septate (Plate V). Conidiophores were simple or rarely branched, continuous, 15-30 microns long, heads were two to seven-spored, in a crown. Conidia were sessile, delicate stipes, ovate to submoniliforme, and measured 4-6 x 3.2-3.7 microns.

As shown in Table 32, the majority of Cephalosporium asperum isolates were obtained from the 1950 and 1951 seed samples.

The author found no reports in the literature where this fungus has been reported from oat seed before this study.

Isolates of this species represented 1.1 per cent of all the fungi for the four-year samples of oat seed.

Table 32. Comparative samples of seed infected with Cephalosporium asperum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
12	1950	Fulton	Sedgwick	(SC)	1
32	1950	Cherokee	Sumner	(SC)	2
35	1950	Cherokee	Coffey	(EC)	1
47	1950	Nemaha	Shawnee	(EC)	4
53	1951	Neosho	Sedgwick	(SC)	1
55	1951	Neosho	Cowley	(SE)	1
62	1951	Cherokee	Brown	(NE)	5
63	1951	Cherokee	Nemaha	(NE)	1
66	1951	Cherokee	Crawford	(SE)	1
69	1951	Nemaha	Mitchell	(NC)	1
74	1951	Nemaha	Brown	(NE)	3
75	1951	Nemaha	Jackson	(NE)	1
77	1951	Nemaha	Morris	(EC)	5
79	1951	Nemaha	Butler	(SE)	1
81	1952	Kanota	Republic	(NC)	1

Mycogone nigra Morgan, var. minor Ruillo. In this colony hyphae were branched and interwoven (Plate VI). Conidia were borne singly on the tips of the conidiophores, dissimilar, two-celled; the upper cell was the larger and usually warted and bright-colored, while the lower cell was pale.

As characterized by Gilman (13), the upper spores were brown, 8-8.4 microns in diameter; lower cell was hyaline, oval, and measured 5.4 x 4 microns.

The source of this isolate is shown in Table 34.

Nigrospora sphaerica (Sacc.) Mason. As presented by Sprague (37), conidiophores were short and erect, grouped and arising from a small stroma (Plate V). Spores were subglobose to definitely flattened, 16-18 (20) microns, black opaque. Sprague also reported that this fungus had been reported from oat seed in Canada. This fungus is more commonly known as the casual organism of "dry rot" of corn.

None of the 1950 samples of seed were infected with Nigrospora sphaerica. The comparative abundance for the other years is shown in Table 33.

Table 33. Comparative samples of seed infected with Nigrospora sphaerica.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
67	1951	Cherokee	Butler	(SE)	1
92	1952	Fulton	Sumner	(SC)	1
100	1952	Cherokee	McPherson	(C)	1
107	1952	Cherokee	Butler	(SE)	1
132	1953	Neosho	Cowley	(SE)	2
146	1953	Nemaha	Ottawa	(NC)	1
153	1953	Nemaha	Osage	(EC)	1

Papularia sphaerosperma (Persoon) von Hoehnel. Sprague (37) stated, "It is doubted if this group is very parasitic, if at all."

For the purpose of identification, the author referred to the description given by Gilman (13).

This colony was spreading, floccose wooly white on the surface; at first white, later it took on a yellowish brown color which was spotted by the occurrence of dark brown to black sclerotia (Plate VI). Conidiophores were prostrate or ascending. Conidia were borne at the apex in an irregular head, on short phialides with inflated bases, lens-shaped, 3 x 9 microns, usually 5-7 microns in diameter, smooth, brown by transmitted light with a hyaline rim around the periphery.

Only one isolate of this fungus was obtained and that occurred in the sample of 1953 Kanota oat seed, which is shown in Table 34.

The author found no reports in the literature where this fungus had been isolated from oat seed prior to this study.

Penicillium frequentans Westling. As presented by Gilman (13), colonies were blue-green to dark blue-green which deepened with age to a darker brown green. The colony was surrounded by a sterile white margin. Conidiophores arose from aerial hyphae and enlarged at the apex to form a swelling 3-4.5 microns in diameter. Heads were 45-115 microns long. Conidia were globose, smooth or slightly verrucose, 2.6-4 microns in diameter.

According to Gilman (13), this species is commonly associated with soil.

This genus and species was found to be associated with only one sample of oat seed, which was rather heavily infected. This was a sample of 1953 Nemaha (shown in Table 34), which was grown in Morris County, in East Central Kansas. In this sample, 7 per cent of the seeds were infected with Penicillium frequentans.

Table 34. Sources of representative isolates of the Moniliaceae family.

Sample No.	Year	Variety	Locality	Fungus percentage per sample
36 *Mycogone nigra var minor*	1950	Cherokee	Wabaunsee (EC)	1
124 *Papularia sphaerosperma*	1953	Kanota	Harper (SC)	1
154 *Penicillium frequentans*	1953	Nemaha	Morris (EC)	7
106	1952	Cherokee	Lyon (EC)	1
141	1953	Cherokee	Linn (EC)	1
Scopulariopsis brevicaulis				
128 *Sepedonium sp.*	1953	Fulton	Sumner (SC)	1

Pullularia pullulans (de Bary) Berkhout. In isolates of this fungus the mycelium darkened with age, always appearing very resupinate and lighter around the margin (Plate VI). Conidia were oval to elongate, hyaline cells, budding from branching, and septate mycelial threads, both terminally and laterally. According to Gilman (13) the conidia, after abstriction, may continue to multiply by budding and abstriction.

As shown in Table 35, this fungus was found in more samples of 1951 seed than in all the other years.

Scopulariopsis brevicaulis Bainier. Colonies were at first white, then yellowish brown or chocolate, consisting of closely-crowded conidiophores making powdery areas intermingled by loose floccose hyphae, with broadly spreading indeterminate margin

Table 35. Comparative samples of seed infected with Pullularia pullulans.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
13	1950	Fulton	Montgomery	(SE)	1
35	1950	Cherokee	Coffey	(EC)	1
51	1951	Neosho	Barton	(C)	1
54	1951	Neosho	Marshall	(NE)	2
59	1951	Cherokee	Marion	(C)	1
68	1951	Nemaha	Osborne	(NC)	1
74	1951	Nemaha	Brown	(NE)	1
75	1951	Nemaha	Jackson	(NE)	2
78	1951	Nemaha	Allen	(SE)	1
97	1952	Cherokee	Cloud	(NC)	1
127	1953	Fulton	Kingman	(SC)	1

(Plate VI). Conidiophores were short, arising directly from the submerged hyphae.

As characterized by Gilman (13), phialides were continuous with conidiophores 12-15 x 4 microns, tapering at the apex. Conidia were somewhat pear-shaped, slightly tuberculate at the apex, and measured 6.5-7.5 x 7.5-9 microns; in mass they appeared a light brown, smooth at first, later the walls were thicker.

There were only two samples of oat seed infected with Scopulariopsis brevicaulis, both of which were shown in Table 34.

Sepedonium sp. The author was unable to identify this isolate to species. The hyphae were creeping, loosely-branched, and conidia were borne at the tips of the final branchlets. Conidia occurred singly or at times two or three, terminal, warty, globose or ovate, hyaline or bright-colored.

This isolate occurred in only one sample of seed, that being a sample of 1953 Fulton which was shown in Table 34.

Sporotrichum roseolum Oudemans and Beijerinck. As given by Gilman (13), the turf was pale rose, very delicate and unrestricted (Plate V). Hyphae was prostrate, irregularly branched, rarely septate, with erect simple or branched laterals which served as conidiophores. Conidia were terminal, globose or oval, in mass pale rose, measuring 3-5 microns in diameter, without vacuoles or guttulae.

The comparative abundance of Sporotrichum roseolum is shown in Table 36.

In the four-year oat samples, this species made up a total of 2.4 per cent of the total isolates for the four-year period. It was found to be more prevalent in the 1951 samples than all others.

The author could not be certain of any correlation between the number of samples infected and the year the sample was collected. Had more samples been tested, perhaps a more definite decision could have been made.

Stilbellaceae. The outstanding characteristic of this form-family is that the conidiophores are united into synnemata, according to Alexopoulos (1).

Isaria sp. The colonies of this fungus were made up of a compact mass of hyphae. Color was a very light pink with a narrow white margin. After about 10 days, black structures resembling synnemata, began to develop. These structures were definitely phototropic since their growth was directed toward available light (Plate VI).

Table 36. Comparative samples of seed infected with Sporotrichum roseolum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
30	1950	Cherokee	Saline	(C)	1
32	1950	Cherokee	Sumner	(SC)	3
35	1950	Cherokee	Coffey	(EC)	1
36	1950	Cherokee	Wabaunsee	(EC)	1
47	1950	Nemaha	Shawnee	(EC)	1
51	1951	Neosho	Barton	(C)	1
53	1951	Neosho	Sedgwick	(SC)	1
54	1951	Neosho	Marshall	(NE)	1
56	1951	Cherokee	Republic	(NC)	2
59	1951	Cherokee	Marion	(C)	1
61	1951	Cherokee	Sedgwick	(SC)	2
62	1951	Cherokee	Brown	(NE)	1
63	1951	Cherokee	Nemaha	(NE)	1
64	1951	Cherokee	Shawnee	(EC)	2
66	1951	Cherokee	Crawford	(SE)	10
69	1951	Nemaha	Mitchell	(NC)	2
74	1951	Nemaha	Brown	(NE)	3
75	1951	Nemaha	Jackson	(NE)	5
76	1951	Nemaha	Wabaunsee	(EC)	2
77	1951	Nemaha	Morris	(EC)	1
78	1951	Nemaha	Allen	(SE)	8
84	1952	Kanota	Kingman	(SC)	1
85	1952	Kanota	Harvey	(SC)	1
90	1952	Fulton	Barton	(C)	1
105	1952	Cherokee	Morris	(EC)	1
110	1952	Nemaha	Cloud	(NC)	1
119	1952	Nemaha	Butler	(SE)	2
133	1953	Cherokee	Clay	(NC)	1
139	1953	Cherokee	Marshall	(NE)	1
144	1953	Cherokee	Chautauqua	(SE)	1
145	1953	Nemaha	Jewell	(NC)	1
148	1953	Nemaha	Barton	(C)	1

Spores were never produced on these colonies of oat isolates although it seemed the terminal ends of the so-called synnemata would be the spore-producing areas.

Samples of this fungus were not restricted to any one sample or area of the state.

There were no isolates from any 1952 seed samples. The greatest single infection occurred in a sample of 1951 Nemaha harvested in Allen County in Southeastern Kansas. The comparative occurrence of this fungus is shown in Table 37.

Table 37. Comparative samples of seed infected with Isaria sp.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
2	1950	Kanota	Clay	(NC)	1
35	1950	Cherokee	Coffey	(EC)	2
55	1951	Neosho	Cowley	(SE)	2
62	1951	Cherokee	Brown	(NE)	1
63	1951	Cherokee	Nemaha	(NE)	2
66	1951	Cherokee	Crawford	(SE)	3
78	1951	Nemaha	Allen	(SE)	4
127	1953	Fulton	Kingman	(SC)	1
134	1953	Cherokee	Jewell	(NC)	1

Tuberculariaceae. The sporodochium is the characteristic structure of the form-family Tuberculariaceae, according to Alexopoulos (1).

Fusarium. Sprague (37) stated:

> The number of species of Fusarium that occur on Gramineae is not great but the artificial system of classification, still in vogue, in part, has so multiplied the number of these subdivisions as to present a considerable array of names.

Few mycologists, according to Alexopoulos (1), ever attempt to identify form-species of Fusarium, since identification is uncertain for all but the few specialists.

The variability which made the identification of form-species of Fusarium uncertain, was accounted for in part by the work of Snyder and Hansen (35). It was their belief, that a number of species were unnecessary because their single spore cultures, repeatedly made, yielded duplicate species represented in the Roseum group.

Only three distinct form-species of Fusarium associated with oat seed were found.

The parasitic fusaria, according to Alexopoulos (1), cause wilts of plants by plugging the conducting tissues and by toxin secretions as well.

Some of the more common names associated with the fusaria are Root Rot, Head Mold, Stem Rot, Mold, Secondary Root Rot, etc.

Fusarium equiseti (Corda) sacc. On potato dextrose, this species produced a peach-colored, cottony colony that later turned buff or medium brown. At first microspores were produced and later macrospores were produced in considerable numbers.

Spores were sickle-shaped, definitely narrowed at the apical cell, mostly 5-celled macroconidia were produced and measured 37-54 x 2.5-5.0 microns.

According to Sprague (37), evidence indicates that Fusarium equiseti is of slight economic importance as a parasite of Gramineae.

This species is more commonly known as Secondary Root Rot. This author could be reasonably certain of only one isolate of this species from oat seed; that being from a sample of 1951 Nemaha from Kingman County in South Central Kansas.

Fusarium moniliforme Sheldon. The mycelium produced by these isolates was generally white, cottony on potato-dextrose agar, or sometimes slightly tinted with rose (Plate VII).

As described by Sprague (37) the outstanding characteristic for identification purposes, was the production of microconidia in chains. He also reported this species as being quite commonly associated with corn ear mold in the Middle West.

The perfect stage of this species is Gibberella moniliformis (Sh.) Wineland, which this author did not find. Sprague (37) stated that this form has been found more often under natural field conditions, on corn stalks.

As shown by Table 38, this fungus occurred only in negligible amounts from oat seed. Greatest infection, which was 5 per cent, occurred in a sample of 1951 Nemaha from Kingman County in South Central Kansas.

Table 38. Comparative samples of seed infected with Fusarium moniliforme.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
72	1951	Nemaha	Kingman	(SC)	5
129	1953	Fulton	Cowley	(SE)	1
140	1953	Cherokee	Leavenworth	(NE)	1
155	1953	Nemaha	Elk	(SE)	1

Fusarium roseum Link sensu Snyder and Hansen. As reported by Sprague (37), isolates of the Fusarium roseum group typically produced red, pink, or wine-colored mycelium (Plate VII).

EXPLANATION OF PLATE VII

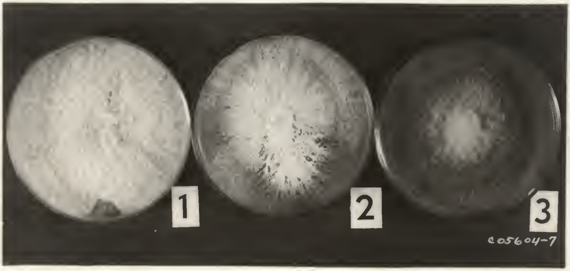
Pure Cultures of:

Fig. 1. *Fusarium roseum*

Fig. 2. *Fusarium moniliforme*

Fig. 3. *Rhizoctonia solani*

PLATE VII



Mycelium ranged from white to buff and carmine-pink substratum, felty, cottony to fluffy. There were no microspores produced. Spore masses were generally a bright carrot color; spores were somewhat acuminate at the distal end, measurements ranged (29) 31-52 (72) x 3.5 x 5.5 microns. Septation was generally 5 and 7 per spore.

There were no isolates of Fusarium roseum recorded from any of the 1952 oat samples.

The greatest number of samples infected with Fusarium roseum, were the 1953 samples which are shown in Table 39.

The greatest amount of infection in a sample, which was 8 per cent, occurred in a sample of 1953 Cherokee from Russell County in Central Kansas.

This group of fusaria constituted 0.8 per cent of all the isolates from oat seed.

Table 39. Comparative samples of seed infected with Fusarium roseum.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
15	1950	Osage	Jewell	(NC)	1
62	1951	Cherokee	Brown	(NE)	1
72	1951	Nemaha	Kingman	(SC)	3
123	1953	Kanota	Reno	(SC)	1
128	1953	Fulton	Sumner	(SC)	5
135	1953	Cherokee	Russell	(C)	8
149	1953	Nemaha	Stafford	(SC)	1
151	1953	Nemaha	Brown	(NE)	1

Fusarium spp. This group of Fusarium isolates which the author was unable to identify to species, represented only a small amount of the total number of isolations.

These isolates were placed in the genus on the basis of the production of either immature, crescent-shaped, multi-septate macroconidia, or on the basis of mycelial chlamydospores, which are commonly produced by Fusaria.

The sources of these isolates are shown in Table 40.

Table 40. Comparative samples of seed infected with Fusarium spp.

Sample No.	Year	Variety	Locality		Fungus percentage per sample
51	1951	Neosho	Barton	(C)	1
72	1951	Nemaha	Kingman	(SC)	2
74	1951	Nemaha	Brown	(NE)	2
76	1951	Nemaha	Wabaunsee	(EC)	1
77	1951	Nemaha	Morris	(EC)	1
105	1952	Cherokee	Morris	(EC)	1

Mycelia Sterilia

In contrast with the other form-orders of the form-class Deuteromycetes, the form-order Mycelia Sterilia produces no known reproductive structures.

Alexopoulos (1), stated that of the 20 or more form-genera in this conglomerate assemblage, Rhizoctonia is one of the two best known and most widely distributed.

Rhizoctonia solani Kuehl. In this isolation the mycelium produced was tan to a reddish-brown and spreading (Plate VII). Constriction at the septa and the right-angled branching were outstanding characteristics according to the description by Sprague (37).

Rhizoctonia solani, as Sprague (37) reported, is prevalent in most soils and attacks a large number of grass hosts during the spring.

Under favorable conditions, the fungus can be rather destructive on cereals, causing deep-seated lesions at the ground line; consequently, when under the stress of wind, the plant breaks off at this point.

This isolate was found associated with a sample of 1953 Neosho from Cowley County in Southeastern Kansas.

UNKNOWNS

This group of isolates were those that failed to produce any type of reproductive structure even after special media was employed to induce sporulation. The author was unable to place any of these in the proper category.

This group represented 3.7 per cent of the total number of isolates from the four year samples of oat seed, although it represented only 0.63 per cent of the seeds infected.

SUMMARY

The oat seed tested in this investigation was obtained from the six eastern agricultural divisions of Kansas.

The seed samples represented the four-year period of 1950 through 1953, and were the six most popular varieties grown during that time, which were Kanota, Fulton, Osage, Neosho, Cherokee, and Nemaha.

After surface sterilization, the seeds were plated out on potato dextrose agar for the purpose of identifying the seed-borne fungi present in those samples.

In all, there were 156 samples of seed tested in this investigation.

The greater percentage of the fungi isolated from oat seed proved to be those generally considered to be of a saprophytic nature, such as Chaetomium, Sordaria, and Alternaria.

Isolates of a parasitic nature were obtained in only negligible amounts and were represented most commonly by such fungi as Helminthosporium and Fusarium.

The fungi identified in this study represented three classes, six orders, eleven families, thirty genera, and fifty species, while the total number of isolates was 2,673.

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APPENDIX

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ADDITIONAL FUNGI REPORTED FROM OATS IN THE LITERATURE

This portion of the thesis has been devoted to those fungi reported in the literature, but not found to be associated with oat seed in Kansas, in this study.

Absidia sp.

This genus (a member of the Phycomycetes) was reported from surface sterilized oat seed by Machecek et al. (25) in studies of cereal seed in Canada. No species determination was made in their study.

Aspergillus circinatus L. Mangin
Periconia circinata (Mangin) Sacc.

This is one of the few Aspergilli that have had an identifiable perfect stage. According to Sprague (37), Leukel found this fungus to be distinct from *Periconia circinata*. Plants which harbored this fungus were found to be proso millets, oats, wheat, and sorghum. It was never found in great abundance.

Candida sp.

This fungus was reportedly isolated in trace amounts from surface sterilized oat seed, in the Canadian studies by Machecek et al. (25). It is a yeast-like fungus, which belongs in the Deuteromycetes.

Cephalothecium roseum Corda

This fungus was reported from surface sterilized oat seed from Eastern Canada by Machecek et al. (25). This fungus generally follows apple-scab and is the cause of pink-rot of apples. Its association with oat seed was more than likely a chance association.

Chaetomium flexosum Palliser

This species of Chaetomium was reported from surface sterilized oat seed in Canada by Machecek et al. (25). As shown in the body of the thesis, this fungus is a member of the Ascomycetes.

Cladosporum herbarum Link

As reported by Sprague (37), this fungus has been associated with many of the Gramineae. The presence of Cladosporum herbarum is many times an indication of the occurrence of more virulent species. It is a member of the Deuteromycetes.

Cryptoascus sp.

As reported by Sprague (37), Cryptoascus was originally reported from oats from Malpeque, Prince Edward Isles, by Hurst in July, 1936. This fungus is a member of the Ascomycetes.

Epicoccum spp.

The range of these fungi is apparently world-wide, according to Sprague (37). Species of Epicoccum occur on ripening heads of grasses and cereals during wet weather. They have been reported as being saprophytic, at most.

Fusarium avenaceum (Fr.) Saccardo

This species of Fusarium has been reported from oats grown in both California and Ohio. It is a common mold on grass and cereal seeds and according to Sprague (37), it is at most a weak parasite.

Fusarium culmorum (W. G. Sm.) Saccardo

This species is commonly known to cause root rot, head mold, and scab. According to Sprague (37), it has been reported from the Great Lakes region westward to western Washington, on oats. *Fusarium culmorum* causes a pre-emergence killing, stunting, and brown root rot of cereals and grasses.

Fusarium graminearum Schw.

This species of Fusarium is known to cause scab and seedling blight. According to Sprague (37), it is especially prevalent in Southern Minnesota and very important in Eastern South Dakota. As shown by Le Clerg (22), this fungus is definitely one of the internal microflora of oat seed.

Fusarium nivale (Fr.) Ces.

This fungus has been reported from oats from only one state which was New Jersey. It is more commonly known as snow mold. According to Sprague (37), some plants are killed outright while others finally recover after warm weather arrives.

Fusarium poae (Pk.) Wr.

Fusarium poae has been reported from oats grown in Ontario, Oregon, and Quebec. In Oregon it was usually found on sterile spikelets. According to Sprague (37), inoculation trials have shown that isolates of this species are comparatively weak parasites or weak saprophytes.

Helminthosporium avenae Eidam

This species of Helminthosporium has been associated with oats in many studies. Helminthosporium avenae, commonly known as the "Leaf Blotch" of oats, causes longitudinal lesions of the coleoptile and root region of seedlings, resulting in stunting and blighting. According to Sprague (37), this fungus is a serious disease of oats in Scotland and Ireland, and moderately important in western Oregon and Canada.

Helminthosporium victoriae Meehan and Murphy

According to Sprague (37), Helminthosporium victoriae has recently appeared in epiphytotic form in the oat growing areas of the Middle West. The worst factor being, it appears to be especially aggressive on a number of rust-resistant type of oats involving crosses with the variety Victoria which has been a serious setback to cooperative investigations. Sprague (37) interjected that perhaps oat growing would be less hazardous in the arid West than the coastal areas.

Penicillium expansum (Lk.) em. Thom

This fungus has been more commonly called "Blue Mold." It has been isolated from oat seed in the Northern Great Plains, the Ohio Valley, and the Pacific Northwest. According to Sprague (37), the seed is definitely damaged by this saprophyte. The weakened seedlings are a result of the reduction of the starchy endosperm. Most injury has been reported to be caused by poor storage conditions after exposure to moisture.

Verticillium sp.

The genus Verticillium was reportedly isolated from oat seed in Eastern Canada. According to Machecek et al. (25), their isolate answered the general description of Cephalosporium acremonium, but it had branched conidiophores so they called it Verticillium.

FUNGI ASSOCIATED WITH OAT SEED IN KANSAS

by

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B. A., University of Wichita, 1953

AN ABSTRACT OF A THESIS

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The purpose of this investigation was the isolation and identification of the fungi associated with oat seed in Kansas.

Since oats are grown primarily in the eastern two-thirds of the state because of restricted growing conditions, seed samples were not collected from the western third of the state.

The varieties tested were the six most popular varieties grown in the four-year period, 1950 through 1953. These varieties were Kanota, Fulton, Osage, Neosho, Cherokee, and Nemaha. There were 156 samples of seed available for this investigation.

The author attempted to obtain two representative samples for each variety grown each year, for each of the six agricultural divisions. Certified seed was used whenever possible. Care was taken to use only one sample for any one county.

Each sample of seed was given an accession number and its origin was recorded. Each lot of 100 seeds was surface sterilized and plated out, 10 to a dish, on potato dextrose agar and allowed to grow at room temperature before any recordings were taken.

Cultures were isolated and placed in test tubes according to their source, for the purpose of future identifications. No attempt was made to identify any of the bacterial isolates although it was noted that the older the seed samples, the more prevalent were the bacterial colonies.

The fungi identified in this study were presented in their respective mycological order in accordance with their classification.

In this study, the identified fungi represented three classes, six orders, eleven families, thirty genera, and fifty species.

Tables were prepared for all fungi to show the comparative infection of the seed samples except where single isolations occurred. If only one isolate was obtained, the data was treated individually in the text.

One of the outstanding characteristics of this study of fungi associated with oat seed, was the ubiquity of Chaetomium, Sordaria, and Alternaria, and the frequency of their occurrence in the samples as compared with other fungi. In contrast, fungi of the genera Helminthosporium and Fusarium were comparatively rare except in one or two heavily infected samples.

In all, there were 2,673 identified isolates in this study of "The fungi associated with oat seed in Kansas."

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